STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION 7

PROPOSAL

DATE AND TIME OF BID OPENING: FEBRUARY 19, 2015 AT 11:00 A.M.

CONTRACT ID: DG00231

WBS ELEMENT NO.: 17BP.7.R.37

COUNTY: GUILFORD

MILES: 0.167

ROUTE NO.: SR 1005 (ALAMANCE CHURCH ROAD)

LOCATION: BRIDGE 238

TYPE OF WORK: BRIDGE REPLACEMENT

NOTICE:

ALL BIDDERS SHALL COMPLY WITH ALL APPLICABLE LAWS REGULATING THE PRACTICE OF GENERAL CONTRACTING AS CONTAINED IN CHAPTER 87 OF THE GENERAL STATUTES OF NORTH CAROLINA WHICH REQUIRES THE BIDDER TO BE LICENSED BY THE N.C. LICENSING BOARD FOR CONTRACTORS WHEN BIDDING ON ANY NON-FEDERAL AID PROJECT WHERE THE BID IS $30,000 OR MORE, EXCEPT FOR CERTAIN SPECIALTY WORK AS DETERMINED BY THE LICENSING BOARD. BIDDERS SHALL ALSO COMPLY WITH ALL OTHER APPLICABLE LAWS REGULATING THE PRACTICES OF ELECTRICAL, PLUMBING, HEATING AND AIR CONDITIONING AND REFRIGERATION CONTRACTING AS CONTAINED IN CHAPTER 87 OF THE GENERAL STATUTES OF NORTH CAROLINA. NOTWITHSTANDING THESE LIMITATIONS ON BIDDING, THE BIDDER WHO IS AWARDED ANY FEDERAL - AID FUNDED PROJECT SHALL COMPLY WITH CHAPTER 87 OF THE GENERAL STATUTES OF NORTH CAROLINA FOR LICENSING REQUIREMENTS WITHIN 60 CALENDAR DAYS OF BID OPENING.

THIS IS A STRUCTURE PROJECT. **BID BOND ARE REQUIRED.**

NAME OF BIDDER

ADDRESS OF BIDDER

PROPOSAL FOR THE CONSTRUCTION OF

CONTRACT No. DG00231 IN GUILFORD COUNTY, NORTH CAROLINA

Date_____ 20_____

DEPARTMENT OF TRANSPORTATION,

RALEIGH, NORTH CAROLINA

The Bidder has carefully examined the location of the proposed work to be known as Contract No. **DG00231**; has carefully examined the plans and specifications, which are acknowledged to be part of the proposal, the special provisions, the proposal, the form of contract, and the forms of contract payment bond and contract performance bond; and thoroughly understands the stipulations, requirements and provisions. The undersigned bidder agrees to bound upon his execution of the bid and subsequent award to him by the Department of Transportation in accordance with this proposal to provide the necessary contract payment bond and contract performance bond within fourteen days after the written notice of award is received by him. The undersigned Bidder further agrees to provide all necessary machinery, tools, labor, and other means of construction; and to do all the work and to furnish all materials, except as otherwise noted, necessary to perform and complete the said contract in accordance with *the 2012 Standard Specifications for Roads and Structures* by the dates(s) specified in the Project Special Provisions and in accordance with the requirements of the Engineer, and at the unit or lump sum prices, as the case may be, for the various items given on the sheets contained herein.

The Bidder shall provide and furnish all the materials, machinery, implements, appliances and tools, and perform the work and required labor to construct and complete State Highway Contract No. **DG00231** in **Guilford County**, for the unit or lump sum prices, as the case may be, bid by the Bidder in his bid and according to the proposal, plans, and specifications prepared by said Department, which proposal, plans, and specifications show the details covering this project, and hereby become a part of this contract.

The published volume entitled *North Carolina Department of Transportation, Raleigh, Standard Specifications for Roads and Structures, January 2012* with all amendments and supplements thereto, is by reference incorporated into and made a part of this contract; that, except as herein modified, all the construction and work included in this contract is to be done in accordance with the specifications contained in said volume, and amendments and supplements thereto, under the direction of the Engineer.

If the proposal is accepted and the award is made, the contract is valid only when signed either by the Contract Officer or such other person as may be designated by the Secretary to sign for the Department of Transportation. The conditions and provisions herein cannot be changed except over the signature of the said Contract Officer or Division Engineer.

The quantities shown in the itemized proposal for the project are considered to be approximate only and are given as the basis for comparison of bids. The Department of Transportation may increase or decrease the quantity of any item or portion of the work as may be deemed necessary or expedient.

An increase or decrease in the quantity of an item will not be regarded as sufficient ground for an increase or decrease in the unit prices, nor in the time allowed for the completion of the work, except as provided for the contract.

Accompanying this bid is a bid bond secured by a corporate surety, or certified check payable to the order of the Department of Transportation, for five percent of the total bid price, which deposit is to be forfeited as liquidated damages in case this bid is accepted and the Bidder shall fail to provide the required payment and performance bonds with the Department of Transportation, under the condition of this proposal, within 14 calendar days after the written notice of award is received by him, as provided in the Standard Specifications; otherwise said deposit will be returned to the Bidder.

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INSTRUCTIONS TO BIDDERS

PLEASE READ ALL INSTRUCTIONS CAREFULLY BEFORE PREPARING AND SUBMITTING YOUR BID.

All bids shall be prepared and submitted in accordance with the following requirements. Failure to comply with any requirement may cause the bid to be considered irregular and may be grounds for rejection of the bid.

1. Download the entire proposal from the Connect NCDOT website, bind and return the entire proposal with your bid.
2. The Bidder should use "Expedite Bid" to complete prepare bids.
3. The Bidder shall submit a unit price for every item. *****Unit Prices shall be rounded off by the bidder to contain no more than FOUR decimal places.*** The computer generated itemized proposal sheets shall be printed and signed by a duly authorized representative in accordance with Subarticle 102-8(A)(8)..**
4. An amount bid shall be entered for every item.
5. Changes to any entry shall be made by marking through the entry in ink and making the correct entry adjacent thereto in ink. A representative of the Bidder shall initial the change in ink. **Do not use correction fluid, correction tape or similar product to make corrections.**
6. The bid shall be properly executed on the included **Execution of Bid – Non-collusion Affidavit, Debarment Certification and Gift Ban Certification** form. All bids shall show the following information:
   a. Name of corporation, partnership, limited liability company, joint venture, individual or firm, submitting bid.
   b. Corporations that have a corporate seal should include it on the bid.
   c. Name of individual or representative submitting bid and position or title held on behalf of the bidder.
   d. Name, signature, and position or title of witness.
   e. Completed attestation by Notary Public
7. **Note: Signer, Witness and Notary Public must be different individuals.**
8. The bid shall not contain any unauthorized additions, deletions, or conditional bids.
9. The Bidder shall not add any provision reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.
10. Contractors who download bid packages **SHALL EMAIL** cthuskins@ncdot.gov a minimum of five (5) days prior to the bid opening to inform NCDOT of your possession of a bid package. BIDS RECEIVED FROM CONTRACTORS WHO HAVE NOT PROVIDED NOTICE OF POSSESSION OF A BID PACKAGE MAY BE REJECTED.
11. **THE PROPOSAL WITH THE ITEMIZED PROPOSAL SHEET ATTACHED SHALL BE PLACED IN A SEALED ENVELOPE AND SHALL BE DELIVERED TO AND RECEIVED IN THE NCDOT DIVISION 7 OFFICE, LOCATED AT 1584 YANCEYVILLE STREET, GREENSBORO, NC 27405 BY 11:00 A.M. ON, THURSDAY, FEBRUARY 19, 2015.**
12. The sealed bid must display the following statement on the front of the sealed envelope:

QUOTATION FOR DG00231
TO BE OPENED AT 11:00 A.M. ON, THURSDAY FEBRUARY 19, 2015.
CONTRACTOR'S NAME

13. **.**If delivered by mail, the sealed envelope shall be placed in another sealed envelope and the outer envelope shall be addressed as follows:

N. C. Department Of Transportation
Attn: Carolyn T. Huskins
1584 Yanceyville Street
Greensboro, NC 27405

PROJECT SPECIAL PROVISIONS - GENERAL

COMPUTER BID PREPARATION REQUIRED:

(7-18-11) 102 SPD 01-050A

The Contractor shall prepare his bid and MBE/WBE or DBE participation electronically by means of a personal computer. The Contractor shall download the Expedite program from the NCDOT "Project Letting" website. Then download the appropriate .ebs electronic file of line items and quantities unique to each project from the Division Office's website.

The only entries into the program which will be permitted by the Bidder are the appropriate unit or lump sum prices for those items which must be bid in order to provide a complete bid for the project, and any MBE/WBE or DBE participation in the appropriate section of the Expedite program. When these entries have been made, the program will automatically prepare a complete set of itemized proposal sheets which will include the amount bid for the various items and the total amount bid for the project in addition to the unit or lump sum prices bid. **The computer generated itemized proposal sheets shall be printed and signed by a duly authorized representative in accordance with Subarticle 102-8(A)(8).** This set of itemized proposal sheets, when submitted together with the appropriate proposal, will constitute the bid and shall be delivered to the appropriate Division Office or location specified in the INSTRUCTIONS TO BIDDERS. Bid prices shall not be written on the itemized proposal sheets bound in the proposal. **The computer generated itemized proposal sheets (.ebs bid file) shall also be copied to a compact disk (CD) furnished by the Contractor and shall be submitted to the Department with the bid.**

In the case of a discrepancy between the unit or lump sum prices submitted on the itemized proposal sheets and those contained on the CD furnished by the Contractor, the unit or lump sum prices submitted on the printed and signed itemized proposal sheets shall prevail.

The requirements of the INSTRUCTIONS TO BIDDERS will apply to the preparation of bids. Changes to any entry on the computer generated itemized proposal sheets shall be made in accordance with requirement Number five (5) of the INSTRUCTIONS TO BIDDERS.

Expedite software necessary for electronic bid preparation may be downloaded from the Connect NCDOT website at: https://connect.ncdot.gov/letting/Pages/EBS-Information.aspx

CONTRACT TIME AND LIQUIDATED DAMAGES:

(8-15-00) (Rev. 12-18-07) 108 SP1 G07 A

The date of availability for this contract is **March 15, 2015**, except that work in jurisdictional waters and wetlands shall not begin until a meeting between the DOT, Regulatory Agencies, and the Contractor is held as stipulated in the permits contained elsewhere in this proposal. This delay in availability has been considered in determining the contract time for this project.

The completion date for this contract is **March 15, 2017**.

Except where otherwise provided by the contract, observation periods required by the contract will not be a part of the work to be completed by the completion date and/or intermediate contract times stated in the contract. The acceptable completion of the

observation periods that extend beyond the final completion date shall be a part of the work covered by the performance and payment bonds.

The liquidated damages for this contract are **Two Hundred Dollars ($ 200.00)** per calendar day. These liquidated damages will not be cumulative with any liquidated damages which may become chargeable under Intermediate Contract Time Number 1.

INTERMEDIATE CONTRACT TIME NUMBER 1 AND LIQUIDATED DAMAGES:
(7-1-95) (Rev. 2-21-12) 108 SP1 G13 A

Except for that work required under the Project Special Provisions entitled *Planting, Reforestation* and/or *Permanent Vegetation Establishment*, included elsewhere in this proposal, the Contractor will be required to complete all work included in this contract and shall place and maintain traffic on same.

The date of availability for this intermediate contract time is **March 15, 2015**.

The completion date for this intermediate contract time is **September 15, 2016**.

The liquidated damages for this intermediate contract time are **Seven Hundred Fifty Dollars ($ 750.00)** per calendar day.

Upon apparent completion of all the work required to be completed by this intermediate date, a final inspection will be held in accordance with Article 105-17 and upon acceptance, the Department will assume responsibility for the maintenance of all work except *Planting, Reforestation* and/or *Permanent Vegetation Establishment*. The Contractor will be responsible for and shall make corrections of all damages to the completed roadway caused by his planting operations, whether occurring prior to or after placing traffic through the project.

INTERMEDIATE CONTRACT TIME NUMBER 2 AND LIQUIDATED DAMAGES:
(2-20-07) 108 SP1 G14 A

The Contractor shall complete the required work of installing, maintaining, and removing the traffic control devices for lane closures and restoring traffic to the existing traffic pattern. The Contractor shall not close or narrow a lane of traffic on **SR1005 (Alamance Church Road)** during the following time restrictions:

DAY AND TIME RESTRICTIONS

Monday thru Saturday Sunset to 9:00 a.m.
Saturday Sunset to Monday 9:00 a.m.

In addition, the Contractor shall not close or narrow a lane of traffic on **SR 1005 (Alamance Church Road)** detain and/or alter the traffic flow on or during holidays, holiday weekends, special events, or any other time when traffic is unusually heavy, including the following schedules:

HOLIDAY AND HOLIDAY WEEKEND LANE CLOSURE RESTRICTIONS

1. For **unexpected occurrence** that creates unusually high traffic volumes, as directed by the Engineer.

2. For **New Year's Day**, between the hours of **sunset** December 31st and **9:00 a.m.** January 2nd. If New Year's Day is on a Friday, Saturday, Sunday or Monday, then until **9:00 a.m.** the following Tuesday.

3. For **Easter**, between the hours of **sunset** Thursday and **9:00 a.m.** Monday.

4. For **Memorial Day**, between the hours of **sunset** Friday and **9:00 a.m.** Tuesday.

5. For **Independence Day**, between the hours of **sunset** the day before Independence Day and **9:00 a.m.** the day after Independence Day.

   If **Independence Day** is on a Friday, Saturday, Sunday or Monday, then between the hours of **sunset** the Thursday before Independence Day and **9:00 a.m** the Tuesday after Independence Day.

6. For **Labor Day**, between the hours of **sunset** Friday and **9:00 a.m.** Tuesday.

7. For **Thanksgiving Day**, between the hours of **sunset** Tuesday and **9:00 a.m.** Monday.

8. For **Christmas**, between the hours of **sunset** the Friday before the week of Christmas Day and **9:00 a.m.** the following Tuesday after the week of Christmas Day.

Holidays and holiday weekends shall include New Year's, Easter, Memorial Day, Independence Day, Labor Day, Thanksgiving, and Christmas. The Contractor shall schedule his work so that lane closures will not be required during these periods, unless otherwise directed by the Engineer.

The time of availability for this intermediate contract work shall be the time the Contractor begins to install all traffic control devices for lane closures according to the time restrictions listed herein.

The completion time for this intermediate contract work shall be the time the Contractor is required to complete the removal of all traffic control devices for lane closures according to the time restrictions stated above and place traffic in the existing traffic pattern.

The liquidated damages are **Seven Hundred Fifty Dollars ($ 750.00)** per hour or portion thereof.

PERMANENT VEGETATION ESTABLISHMENT:

Establish a permanent stand of the vegetation mixture shown in the contract. During the period between initial vegetation planting and final project acceptance, perform all work necessary to establish permanent vegetation on all erodible areas within the project limits, as

well as, in borrow and waste pits. This work shall include erosion control device maintenance and installation, repair seeding and mulching, supplemental seeding and mulching, mowing, and fertilizer topdressing, as directed. All work shall be performed in accordance with the applicable section of the *2012 Standard Specifications*. All work required for initial vegetation planting shall be performed as a part of the work necessary for the completion and acceptance of the Intermediate Contract Time (ICT). Between the time of ICT and Final Project acceptance, or otherwise referred to as the vegetation establishment period, the Department will be responsible for preparing the required National Pollutant Discharge Elimination System (NPDES) inspection records.

Once the Engineer has determined that the permanent vegetation establishment requirement has been achieved at an 80% vegetation density (the amount of established vegetation per given area to stabilize the soil) and no erodible areas exist within the project limits, the Contractor will be notified to remove the remaining erosion control devices that are no longer needed. The Contractor will be responsible for, and shall correct any areas disturbed by operations performed in permanent vegetation establishment and the removal of temporary erosion control measures, whether occurring prior to or after placing traffic on the project.

Payment for *Response for Erosion Control*, *Seeding and Mulching, Repair Seeding, Supplemental Seeding, Mowing, Fertilizer Topdressing, Silt Excavation,* and *Stone for Erosion Control* will be made at contract unit prices for the affected items. Work required that is not represented by contract line items will be paid in accordance with Articles 104-7 or 104-3 of the *2012 Standard Specifications*. No additional compensation will be made for maintenance and removal of temporary erosion control items.

NO MAJOR CONTRACT ITEMS:

(2-19-02) (Rev. 8-21-07) 104 SP1 G31

None of the items included in this contract will be major items.

NO SPECIALTY ITEMS:

(7-1-95) 108-6 SP1 G34

None of the items included in this contract will be specialty items (see Article 108-6 of the *2012 Standard Specifications*).

FUEL PRICE ADJUSTMENT:

(11-15-05) (Rev. 2-18-14) 109-8 SP1 G43

Revise the *2012 Standard Specifications* as follows:

Page 1-83, Article 109-8, Fuel Price Adjustments, add the following:

The base index price for DIESEL #2 FUEL is **$ 2.0538** per gallon. Where any of the following are included as pay items in the contract, they will be eligible for fuel price adjustment.

The pay items and the fuel factor used in calculating adjustments to be made will be as follows:

Description	Units	Fuel Usage Factor Diesel
Asphalt Concrete Base Course, Type ____	Gal/Ton	2.90
Asphalt Concrete Intermediate Course, Type ____	Gal/Ton	2.90
Asphalt Concrete Surface Course, Type ____	Gal/Ton	2.90

SCHEDULE OF ESTIMATED COMPLETION PROGRESS:

(7-15-08) (Rev. 5-20-14) 108-2 SP1 G58

The Contractor's attention is directed to the Standard Special Provision entitled *Availability of Funds Termination of Contracts* included elsewhere in this proposal. The Department of Transportation's schedule of estimated completion progress for this project as required by that Standard Special Provision is as follows:

2015	(7/01/14 - 6/30/15)	**15** % of Total Amount Bid
2016	(7/01/15 - 6/30/16)	**70** % of Total Amount Bid
2017	(7/01/16 - 6/30/17)	**15** % of Total Amount Bid

The Contractor shall also furnish his own progress schedule in accordance with Article 108-2 of the *2012 Standard Specifications*. Any acceleration of the progress as shown by the Contractor's progress schedule over the progress as shown above shall be subject to the approval of the Engineer.

MINORITY BUSINESS ENTERPRISE AND WOMEN BUSINESS ENTERPRISE (DIVISIONS):

(10-16-07)(Rev. 12-17-13) 102-15(J) SP1 G67

Description

The purpose of this Special Provision is to carry out the North Carolina Department of Transportation's policy of ensuring nondiscrimination in the award and administration of contracts financed in whole or in part with State funds.

Definitions

Additional MBE/WBE Subcontractors - Any MBE/WBE submitted at the time of bid that will not be used to meet either the MBE or WBE goal. No submittal of a Letter of Intent is required.

Committed MBE/WBE Subcontractor - Any MBE/WBE submitted at the time of bid that is being used to meet either the MBE or WBE goal by submission of a Letter of Intent. Or any MBE or WBE used as a replacement for a previously committed MBE or WBE firm.

Contract Goals Requirement - The approved MBE and WBE participation at time of award, but not greater than the advertised contract goals for each.

Goal Confirmation Letter - Written documentation from the Department to the bidder confirming the Contractor's approved, committed MBE and WBE participation along with a listing of the committed MBE and WBE firms.

Manufacturer - A firm that operates or maintains a factory or establishment that produces on the premises, the materials or supplies obtained by the Contractor.

MBE Goal - A portion of the total contract, expressed as a percentage, that is to be performed by committed MBE subcontractor(s).

Minority Business Enterprise (MBE) - A firm certified as a Disadvantaged Minority-Owned Business Enterprise through the North Carolina Unified Certification Program.

Regular Dealer - A firm that owns, operates, or maintains a store, warehouse, or other establishment in which the materials or supplies required for the performance of the contract are bought, kept in stock, and regularly sold to the public in the usual course of business. A regular dealer engages in, as its principal business and in its own name, the purchase and sale or lease of the products in question. A regular dealer in such bulk items as steel, cement, gravel, stone, and petroleum products need not keep such products in stock, if it owns and operates distribution equipment for the products. Brokers and packagers are not regarded as manufacturers or regular dealers within the meaning of this section.

North Carolina Unified Certification Program (NCUCP) - A program that provides comprehensive services and information to applicants for MBE/WBE certification. The MBE/WBE program follows the same regulations as the federal Disadvantaged Business Enterprise (DBE) program in accordance with 49 CFR Part 26.

United States Department of Transportation (USDOT) - Federal agency responsible for issuing regulations (49 CFR Part 26) and official guidance for the DBE program.

WBE Goal - A portion of the total contract, expressed as a percentage, that is to be performed by committed WBE subcontractor(s).

Women Business Enterprise (WBE) - A firm certified as a Disadvantaged Women-Owned Business Enterprise through the North Carolina Unified Certification Program.

Forms and Websites Referenced in this Provision

Payment Tracking System - On-line system in which the Contractor enters the payments made to MBE and WBE subcontractors who have performed work on the project. https://apps.dot.state.nc.us/Vendor/PaymentTracking/

DBE-IS *Subcontractor Payment Information* - Form for reporting the payments made to all MBE/WBE firms working on the project. This form is for paper bid projects only. http://www.ncdot.org/doh/forms/files/DBE-IS.xls

RF-1 *MBE/WBE Replacement Request Form* - Form for replacing a committed MBE or WBE.
http://connect.ncdot.gov/projects/construction/Construction%20Forms/DBE%20MBE%20WBE%20Replacement%20Request%20Form.pdf

SAF *Subcontract Approval Form* - Form required for approval to sublet the contract.

http://connect.ncdot.gov/projects/construction/Construction%20Forms/Subcontract%20Approval%20Form%20Rev.%202012.zip

JC-1 *Joint Check Notification Form* - Form and procedures for joint check notification. The form acts as a written joint check agreement among the parties providing full and prompt disclosure of the expected use of joint checks.
http://connect.ncdot.gov/projects/construction/Construction%20Forms/Joint%20Check%20Notification%20Form.pdf

Letter of Intent - Form signed by the Contractor and the MBE/WBE subcontractor, manufacturer or regular dealer that affirms that a portion of said contract is going to be performed by the signed MBE/WBE for the amount listed at the time of bid.
http://connect.ncdot.gov/letting/LetCentral/Letter%20of%20Intent%20to%20Perform%20as%20a%20Subcontractor.pdf

Listing of MBE and WBE Subcontractors Form - Form for entering MBE/WBE subcontractors on a project that will meet this MBE and WBE goals. This form is for paper bids only.
http://connect.ncdot.gov/municipalities/Bid%20Proposals%20for%20LGA%20Content/09%20MBE-WBE%20Subcontractors%20(State).doc

Subcontractor Quote Comparison Sheet - Spreadsheet for showing all subcontractor quotes in the work areas where MBEs and WBEs quoted on the project. This sheet is submitted with good faith effort packages.
http://connect.ncdot.gov/business/SmallBusiness/Documents/DBE%20Subcontractor%20Quote%20Comparison%20Example.xls

MBE and WBE Goal

The following goals for participation by Minority Business Enterprises and Women Business Enterprises are established for this contract:

(A) Minority Business Enterprises **1.0 %**

(1) *If the MBE goal is more than zero*, the Contractor shall exercise all necessary and reasonable steps to ensure that MBEs participate in at least the percent of the contract as set forth above as the MBE goal.

(2) *If the MBE goal is zero*, the Contractor shall make an effort to recruit and use MBEs during the performance of the contract. Any MBE participation obtained shall be reported to the Department.

(B) Women Business Enterprises **4.0 %**

(1) *If the WBE goal is more than zero*, the Contractor shall exercise all necessary and reasonable steps to ensure that WBEs participate in at least the percent of the contract as set forth above as the WBE goal.

(2) *If the WBE goal is zero,* the Contractor shall make an effort to recruit and use WBEs during the performance of the contract. Any WBE participation obtained shall be reported to the Department.

Directory of Transportation Firms (Directory)

Real-time information is available about firms doing business with the Department and firms that are certified through NCUCP in the Directory of Transportation Firms. Only firms identified in the Directory as MBE and WBE certified shall be used to meet the MBE and WBE goals respectively. The Directory can be found at the following link. https://partner.ncdot.gov/VendorDirectory/default.html

The listing of an individual firm in the directory shall not be construed as an endorsement of the firm's capability to perform certain work.

Listing of MBE/WBE Subcontractors

At the time of bid, bidders shall submit all MBE and WBE participation that they anticipate to use during the life of the contract. Only those identified to meet the MBE goal and the WBE goal will be considered committed, even though the listing shall include both committed MBE/WBE subcontractors and additional MBE/WBE subcontractors. Any additional MBE/WBE subcontractor participation submitted at the time of bid will be used toward overall race-neutral goals. Only those firms with current MBE and WBE certification at the time of bid opening will be acceptable for listing in the bidder's submittal of MBE and WBE participation. The Contractor shall indicate the following required information:

(A) *If either the MBE or WBE goal is more than zero,*

(1) Bidders, at the time the bid proposal is submitted, shall submit a listing of MBE/WBE participation, including the names and addresses on *Listing of MBE and WBE Subcontractors* contained elsewhere in the contract documents in order for the bid to be considered responsive. Bidders shall indicate the total dollar value of the MBE and WBE participation for the contract.

(2) If bidders have no MBE or WBE participation, they shall indicate this on the *Listing of MBE and WBE Subcontractors* by entering the word "None" or the number "0." This form shall be completed in its entirety. **Blank forms will not be deemed to represent zero participation.** Bids submitted that do not have MBE and WBE participation indicated on the appropriate form will not be read publicly during the opening of bids. The Department will not consider these bids for award and the proposal will be rejected.

(3) The bidder shall be responsible for ensuring that the MBE/WBE is certified at the time of bid by checking the Directory of Transportation Firms. If the firm is not certified at the time of the bid-letting, that MBE's or WBE's participation will not count towards achieving the corresponding goal.

(B) *If either the MBE or WBE goal is zero,* entries on the *Listing of MBE and WBE Subcontractors* are not required for the zero goal, however any MBE or WBE

participation that is achieved during the project shall be reported in accordance with requirements contained elsewhere in the special provision.

MBE or WBE Prime Contractor

When a certified MBE or WBE firm bids on a contract that contains MBE and WBE goals, the firm is responsible for meeting the goals or making good faith efforts to meet the goals, just like any other bidder. In most cases, a MBE or WBE bidder on a contract will meet one of the goals by virtue of the work it performs on the contract with its own forces. However, all the work that is performed by the MBE or WBE bidder and any other similarly certified subcontractors will count toward the goal. The MBE or WBE bidder shall list itself along with any MBE or WBE subcontractors, if any, in order to receive credit toward the goals.

For example, on a proposed contract, the WBE goal is 10%, and the MBE goal is 8%. A WBE bidder puts in a bid where they will perform 40% of the contract work and have a WBE subcontractor which will perform another 5% of the work. Together the two WBE firms submit on the *Listing of MBE and WBE Subcontractors* a value of 45% of the contract which fulfills the WBE goal. The 8% MBE goal shall be obtained through MBE participation with MBE certified subcontractors or documented through a good faith effort. It should be noted that you cannot combine the two goals to meet an overall value. The two goals shall remain separate.

MBE/WBE prime contractors shall also follow Sections A or B listed under *Listing of MBE/WBE Subcontractors* just as a non-MBE/WBE bidder would.

Written Documentation – Letter of Intent

The bidder shall submit written documentation for each MBE/WBE that will be used to meet the MBE and WBE goals of the contract, indicating the bidder's commitment to use the MBE/WBE in the contract. This documentation shall be submitted on the Department's form titled *Letter of Intent.*

The documentation shall be received in the office of the Engineer no later than 12:00 noon of the sixth calendar day following opening of bids, unless the sixth day falls on Saturday, Sunday or an official state holiday. In that situation, it is due in the office of the Engineer no later than 12:00 noon on the next official state business day.

If the bidder fails to submit the Letter of Intent from each committed MBE and WBE to be used toward the MBE and WBE goals, or if the form is incomplete (i.e. both signatures are not present), the MBE/WBE participation will not count toward meeting the MBE/WBE goal. If the lack of this participation drops the commitment below either the MBE or WBE goal, the Contractor shall submit evidence of good faith efforts for the goal not met, completed in its entirety, to the Engineer no later than 12:00 noon of the eighth calendar day following opening of bids, unless the eighth day falls on Saturday, Sunday or an official state holiday. In that situation, it is due in the office of the Engineer no later than 12:00 noon on the next official state business day.

Submission of Good Faith Effort

If the bidder fails to meet or exceed either the MBE or the WBE goal, the apparent lowest responsive bidder shall submit to the Department documentation of adequate good faith efforts made to reach that specific goal(s).

One complete set and **6** copies of this information shall be received in the office of the Engineer no later than 12:00 noon of the sixth calendar day following opening of bids, unless the sixth day falls on Saturday, Sunday or an official state holiday. In that situation, it is due in the office of the Engineer no later than 12:00 noon on the next official state business day.

Note: Where the information submitted includes repetitious solicitation letters, it will be acceptable to submit a representative letter along with a distribution list of the firms that were solicited. Documentation of MBE/WBE quotations shall be a part of the good faith effort submittal. This documentation may include written subcontractor quotations, telephone log notations of verbal quotations, or other types of quotation documentation.

Consideration of Good Faith Effort for Projects with MBE/WBE Goals More Than Zero

Adequate good faith efforts mean that the bidder took all necessary and reasonable steps to achieve the goal which, by their scope, intensity, and appropriateness, could reasonably be expected to obtain sufficient MBE/WBE participation. Adequate good faith efforts also mean that the bidder actively and aggressively sought MBE/WBE participation. Mere *pro forma* efforts are not considered good faith efforts.

The Department will consider the quality, quantity, and intensity of the different kinds of efforts a bidder has made. Listed below are examples of the types of actions a bidder will take in making a good faith effort to meet the goals and are not intended to be exclusive or exhaustive, nor is it intended to be a mandatory checklist.

(A) Soliciting through all reasonable and available means (e.g. attendance at pre-bid meetings, advertising, written notices, use of verifiable electronic means through the use of the NCDOT Directory of Transportation Firms) the interest of all certified MBEs/WBEs who have the capability to perform the work of the contract. The bidder must solicit this interest within at least 10 days prior to bid opening to allow the MBEs/WBEs to respond to the solicitation. Solicitation shall provide the opportunity to MBEs/WBEs within the Division and surrounding Divisions where the project is located. The bidder must determine with certainty if the MBEs/WBEs are interested by taking appropriate steps to follow up initial solicitations.

(B) Selecting portions of the work to be performed by MBEs/WBEs in order to increase the likelihood that the MBE and WBE goals will be achieved.

(1) Where appropriate, break out contract work items into economically feasible units to facilitate MBE/WBE participation, even when the prime contractor might otherwise prefer to perform these work items with its own forces.

(2) Negotiate with subcontractors to assume part of the responsibility to meet the contract MBE/WBE goals when the work to be sublet includes potential for MBE/WBE participation (2^{nd} and 3^{rd} tier subcontractors).

(C) Providing interested MBEs/WBEs with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.

(D) (1) Negotiating in good faith with interested MBEs/WBEs. It is the bidder's responsibility to make a portion of the work available to MBE/WBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available MBE/WBE subcontractors and suppliers, so as to facilitate MBE/WBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of MBEs/WBEs that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for MBEs/WBEs to perform the work.

(2) A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including MBE/WBE subcontractors, and would take a firm's price and capabilities as well as contract goals into consideration. However, the fact that there may be some additional costs involved in finding and using MBEs/WBEs is not in itself sufficient reason for a bidder's failure to meet the contract MBE or WBE goals, as long as such costs are reasonable. Also, the ability or desire of a prime contractor to perform the work of a contract with its own organization does not relieve the bidder of the responsibility to make good faith efforts. Bidding contractors are not, however, required to accept higher quotes from MBEs/WBEs if the price difference is excessive or unreasonable.

(E) Not rejecting MBEs/WBEs as being unqualified without sound reasons based on a thorough investigation of their capabilities. The bidder's standing within its industry, membership in specific groups, organizations, or associates and political or social affiliations (for example, union vs. non-union employee status) are not legitimate causes for the rejection or non-solicitation of bids in the bidder's efforts to meet the project goal.

(F) Making efforts to assist interested MBEs/WBEs in obtaining bonding, lines of credit, or insurance as required by the recipient or bidder.

(G) Making efforts to assist interested MBEs/WBEs in obtaining necessary equipment, supplies, materials, or related assistance or services.

(H) Effectively using the services of available minority/women community organizations; minority/women contractors' groups; Federal, State, and local minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of MBEs/WBEs. Contact within 7 days from the bid opening NCDOT's Business Development

Manager in the Business Opportunity and Work Force Development Unit to give notification of the bidder's inability to get MBE or WBE quotes.

(I) Any other evidence that the bidder submits which shows that the bidder has made reasonable good faith efforts to meet the MBE and WBE goal.

In addition, the Department may take into account the following:

(1) Whether the bidder's documentation reflects a clear and realistic plan for achieving the MBE and WBE goals.

(2) The bidders' past performance in meeting the MBE and WBE goals.

(3) The performance of other bidders in meeting the MBE and WBE goals. For example, when the apparent successful bidder fails to meet the goals, but others meet it, you may reasonably raise the question of whether, with additional reasonable efforts the apparent successful bidder could have met the goals. If the apparent successful bidder fails to meet the MBE and WBE goals, but meets or exceeds the average MBE and WBE participation obtained by other bidders, the Department may view this, in conjunction with other factors, as evidence of the apparent successful bidder having made a good faith effort.

If the Department does not award the contract to the apparent lowest responsive bidder, the Department reserves the right to award the contract to the next lowest responsive bidder that can satisfy to the Department that the MBE and WBE goals can be met or that an adequate good faith effort has been made to meet the MBE and WBE goals.

Non-Good Faith Appeal

The Engineer will notify the contractor verbally and in writing of non-good faith. A contractor may appeal a determination of non-good faith made by the Goal Compliance Committee. If a contractor wishes to appeal the determination made by the Committee, they shall provide written notification to the Engineer. The appeal shall be made within 2 business days of notification of the determination of non-good faith.

Counting MBE/WBE Participation Toward Meeting MBE/WBE Goals

(A) Participation

The total dollar value of the participation by a committed MBE/WBE will be counted toward the contract goal requirements. The total dollar value of participation by a committed MBE/WBE will be based upon the value of work actually performed by the MBE/WBE and the actual payments to MBE/WBE firms by the Contractor.

(B) Joint Checks

Prior notification of joint check use shall be required when counting MBE/WBE participation for services or purchases that involves the use of a joint

check. Notification shall be through submission of Form JC-1 *(Joint Check Notification Form)* and the use of joint checks shall be in accordance with the Department's Joint Check Procedures.

(C) Subcontracts (Non-Trucking)

A MBE/WBE may enter into subcontracts. Work that a MBE subcontracts to another MBE firm may be counted toward the MBE contract goal requirement. The same holds for work that a WBE subcontracts to another WBE firm. Work that a MBE subcontracts to a non-MBE firm does not count toward the MBE contract goal requirement. Again, the same holds true for the work that a WBE subcontracts to a non-WBE firm. If a MBE or WBE contractor or subcontractor subcontracts a significantly greater portion of the work of the contract than would be expected on the basis of standard industry practices, it shall be presumed that the MBE or WBE is not performing a commercially useful function. The MBE/WBE may present evidence to rebut this presumption to the Department. The Department's decision on the rebuttal of this presumption may be subject to review by the Office of Inspector General, NCDOT.

(D) Joint Venture

When a MBE or WBE performs as a participant in a joint venture, the Contractor may count toward its contract goal requirement a portion of the total value of participation with the MBE or WBE in the joint venture, that portion of the total dollar value being a distinct clearly defined portion of work that the MBE or WBE performs with its forces.

(E) Suppliers

A contractor may count toward its MBE or WBE requirement 60 percent of its expenditures for materials and supplies required to complete the contract and obtained from a MBE or WBE regular dealer and 100 percent of such expenditures from a MBE or WBE manufacturer.

(F) Manufacturers and Regular Dealers

A contractor may count toward its MBE or WBE requirement the following expenditures to MBE/WBE firms that are not manufacturers or regular dealers:

(1) The fees or commissions charged by a MBE/WBE firm for providing a *bona fide* service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of a DOT-assisted contract, provided the fees or commissions are determined to be reasonable and not excessive as compared with fees and commissions customarily allowed for similar services.

(2) With respect to materials or supplies purchased from a MBE/WBE, which is neither a manufacturer nor a regular dealer, count the entire amount of fees or

commissions charged for assistance in the procurement of the materials and supplies, or fees or transportation charges for the delivery of materials or supplies required on a job site (but not the cost of the materials and supplies themselves), provided the fees are determined to be reasonable and not excessive as compared with fees customarily allowed for similar services.

Commercially Useful Function

(A) MBE/WBE Utilization

The Contractor may count toward its contract goal requirement only expenditures to MBEs and WBEs that perform a commercially useful function in the work of a contract. A MBE/WBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. To perform a commercially useful function, the MBE/WBE shall also be responsible with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material and installing (where applicable) and paying for the material itself. To determine whether a MBE/WBE is performing a commercially useful function, the Department will evaluate the amount of work subcontracted, industry practices, whether the amount the firm is to be paid under the contract is commensurate with the work it is actually performing and the MBE/WBE credit claimed for its performance of the work, and any other relevant factors.

(B) MBE/WBE Utilization in Trucking

The following factors will be used to determine if a MBE or WBE trucking firm is performing a commercially useful function:

(1) The MBE/WBE shall be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there shall not be a contrived arrangement for the purpose of meeting the MBE or WBE goal.

(2) The MBE/WBE shall itself own and operate at least one fully licensed, insured, and operational truck used on the contract.

(3) The MBE/WBE receives credit for the total value of the transportation services it provides on the contract using trucks it owns, insures, and operates using drivers it employs.

(4) The MBE may subcontract the work to another MBE firm, including an owner-operator who is certified as a MBE. The same holds true that a WBE may subcontract the work to another WBE firm, including an owner-operator who is certified as a WBE. When this occurs, the MBE or WBE who subcontracts work receives credit for the total value of the transportation services the subcontracted MBE or WBE provides on the contract. It should be noted that every effort shall be made by MBE and WBE contractors to

subcontract to the same certification (i.e., MBEs to MBEs and WBEs to WBEs), in order to fulfill the goal requirement. This, however, may not always be possible due to the limitation of firms in the area. If the MBE or WBE firm shows a good faith effort has been made to reach out to similarly certified transportation service providers and there is no interest or availability, and they can get assistance from other certified providers, the Engineer will not hold the prime liable for meeting the goal.

(5) The MBE/WBE may also subcontract the work to a non-MBE/WBE firm, including from an owner-operator. The MBE/WBE who subcontracts the work to a non-MBE/WBE is entitled to credit for the total value of transportation services provided by the non-MBE/WBE subcontractor not to exceed the value of transportation services provided by MBE/WBE-owned trucks on the contract. Additional participation by non-MBE/WBE subcontractors receives credit only for the fee or commission it receives as a result of the subcontract arrangement. The value of services performed under subcontract agreements between the MBE/WBE and the Contractor will not count towards the MBE/WBE contract requirement.

(6) A MBE/WBE may lease truck(s) from an established equipment leasing business open to the general public. The lease must indicate that the MBE/WBE has exclusive use of and control over the truck. This requirement does not preclude the leased truck from working for others during the term of the lease with the consent of the MBE/WBE, so long as the lease gives the MBE/WBE absolute priority for use of the leased truck. This type of lease may count toward the MBE/WBE's credit as long as the driver is under the MBE/WBE's payroll.

(7) Subcontracted/leased trucks shall display clearly on the dashboard the name of the MBE/WBE that they are subcontracted/leased to and their own company name if it is not identified on the truck itself. Magnetic door signs are not permitted.

MBE/WBE Replacement

When a Contractor has relied on a commitment to a MBE or WBE firm (or an approved substitute MBE or WBE firm) to meet all or part of a contract goal requirement, the contractor shall not terminate the MBE/WBE for convenience. This includes, but is not limited to, instances in which the Contractor seeks to perform the work of the terminated subcontractor with another MBE/WBE subcontractor, a non-MBE/WBE subcontractor, or with the Contractor's own forces or those of an affiliate. A MBE/WBE may only be terminated after receiving the Engineer's written approval based upon a finding of good cause for the termination.

All requests for replacement of a committed MBE/WBE firm shall be submitted to the Engineer for approval on Form RF-1 *(Replacement Request).* If the Contractor fails to follow this procedure, the Contractor may be disqualified from further bidding for a period of up to 6 months.

The Contractor shall comply with the following for replacement of a committed MBE/WBE:

(A) Performance Related Replacement

When a committed MBE is terminated for good cause as stated above, an additional MBE that was submitted at the time of bid may be used to fulfill the MBE commitment. The same holds true if a committed WBE is terminated for good cause, an additional WBE that was submitted at the time of bid may be used to fulfill the WBE goal. A good faith effort will only be required for removing a committed MBE/WBE if there were no additional MBEs/WBEs submitted at the time of bid to cover the same amount of work as the MBE/WBE that was terminated.

If a replacement MBE/WBE is not found that can perform at least the same amount of work as the terminated MBE/WBE, the Contractor shall submit a good faith effort documenting the steps taken. Such documentation shall include, but not be limited to, the following:

(1) Copies of written notification to MBEs/WBEs that their interest is solicited in contracting the work defaulted by the previous MBE/WBE or in subcontracting other items of work in the contract.

(2) Efforts to negotiate with MBEs/WBEs for specific subbids including, at a minimum:

(a) The names, addresses, and telephone numbers of MBEs/WBEs who were contacted.
(b) A description of the information provided to MBEs/WBEs regarding the plans and specifications for portions of the work to be performed.

(3) A list of reasons why MBE/WBE quotes were not accepted.

(4) Efforts made to assist the MBEs/WBEs contacted, if needed, in obtaining bonding or insurance required by the Contractor.

(B) Decertification Replacement

(1) When a committed MBE/WBE is decertified by the Department after the SAF (*Subcontract Approval Form*) has been received by the Department, the Department will not require the Contractor to solicit replacement MBE/WBE participation equal to the remaining work to be performed by the decertified firm. The participation equal to the remaining work performed by the decertified firm will count toward the contract goal requirement.

(2) When a committed MBE/WBE is decertified prior to the Department receiving the SAF (*Subcontract Approval Form*) for the named MBE/WBE firm, the Contractor shall take all necessary and reasonable steps to replace the MBE/WBE subcontractor with another similarly certified MBE/WBE subcontractor to perform at least the same amount of work to meet the MBE/WBE goal requirement. If a MBE/WBE firm is not found to do the

same amount of work, a good faith effort must be submitted to NCDOT (see A herein for required documentation).

Changes in the Work

When the Engineer makes changes that result in the reduction or elimination of work to be performed by a committed MBE/WBE, the Contractor will not be required to seek additional participation. When the Engineer makes changes that result in additional work to be performed by a MBE/WBE based upon the Contractor's commitment, the MBE/WBE shall participate in additional work to the same extent as the MBE/WBE participated in the original contract work.

When the Engineer makes changes that result in extra work, which has more than a minimal impact on the contract amount, the Contractor shall seek additional participation by MBEs/WBEs unless otherwise approved by the Engineer.

When the Engineer makes changes that result in an alteration of plans or details of construction, and a portion or all of the work had been expected to be performed by a committed MBE/WBE, the Contractor shall seek participation by MBEs/WBEs unless otherwise approved by the Engineer.

When the Contractor requests changes in the work that result in the reduction or elimination of work that the Contractor committed to be performed by a MBE/WBE, the Contractor shall seek additional participation by MBEs/WBEs equal to the reduced MBE/WBE participation caused by the changes.

Reports and Documentation

A SAF (*Subcontract Approval Form*) shall be submitted for all work which is to be performed by a MBE/WBE subcontractor. The Department reserves the right to require copies of actual subcontract agreements involving MBE/WBE subcontractors.

When using transportation services to meet the contract commitment, the Contractor shall submit a proposed trucking plan in addition to the SAF. The plan shall be submitted prior to beginning construction on the project. The plan shall include the names of all trucking firms proposed for use, their certification type(s), the number of trucks owned by the firm, as well as the individual truck identification numbers, and the line item(s) being performed.

Within 30 calendar days of entering into an agreement with a MBE/WBE for materials, supplies or services, not otherwise documented by the SAF as specified above, the Contractor shall furnish the Engineer a copy of the agreement. The documentation shall also indicate the percentage (60% or 100%) of expenditures claimed for MBE/WBE credit.

Reporting Minority and Women Business Enterprise Participation

The Contractor shall provide the Engineer with an accounting of payments made to all MBE and WBE firms, including material suppliers and contractors at all levels (prime, subcontractor, or second tier subcontractor). This accounting shall be furnished to the

Engineer for any given month by the end of the following month. Failure to submit this information accordingly may result in the following action:

(A) Withholding of money due in the next partial pay estimate; or

(B) Removal of an approved contractor from the prequalified bidders' list or the removal of other entities from the approved subcontractors list.

While each contractor (prime, subcontractor, 2nd tier subcontractor) is responsible for accurate accounting of payments to MBEs/WBEs, it shall be the prime contractor's responsibility to report all monthly and final payment information in the correct reporting manner.

Failure on the part of the Contractor to submit the required information in the time frame specified may result in the disqualification of that contractor and any affiliate companies from further bidding until the required information is submitted.

Failure on the part of any subcontractor to submit the required information in the time frame specified may result in the disqualification of that contractor and any affiliate companies from being approved for further work on future projects until the required information is submitted.

Contractors reporting transportation services provided by non-MBE/WBE lessees shall evaluate the value of services provided during the month of the reporting period only.

At any time, the Engineer can request written verification of subcontractor payments.

The Contractor shall report the accounting of payments on the Department's DBE-IS *(Subcontractor Payment Information)* with each invoice. Invoices will not be processed for payment until the DBE-IS is received.

Failure to Meet Contract Requirements

Failure to meet contract requirements in accordance with Subarticle 102-15(J) of the *2012 Standard Specifications* may be cause to disqualify the Contractor.

SUBSURFACE INFORMATION:

(7-1-95) 450 SP1 G112 C

Subsurface information is available on the structure portion of this project only.

LOCATING EXISTING UNDERGROUND UTILITIES:

(3-20-12) 105 SP1 G115

Revise the *2012 Standard Specifications* as follows:

Page 1-43, Article 105-8, line 28, after the first sentence, add the following:

Identify excavation locations by means of pre-marking with white paint, flags, or stakes or provide a specific written description of the location in the locate request.

RESOURCE CONSERVATION:

(5-21-13) 104-13 SP1 G118

In accordance with North Carolina Executive Order 156, NCGS 130A-309.14(2), and NCGS 136-28.8, it is the policy of the Department to aid in the reduction of materials that become a part of our solid waste stream, to divert materials from landfills, and to find ways to recycle and reuse materials for the benefit of the Citizens of North Carolina.

Initiate, develop and use products and construction methods that incorporate the use of recycled or solid waste products in accordance with Article 104-13 of the *2012 Standard Specifications*. Report the quantities of reused or recycled materials either incorporated in the project or diverted from landfills on the Project Construction Reuse and Recycling Reporting Form.

A location-based tool for finding local recycling facilities and the Project Construction Reuse and Recycling Reporting Form are available at:

http://connect.ncdot.gov/resources/Environmental/Pages/North-Carolina-Recycling-Locations.aspx

DOMESTIC STEEL:

(4-16-13) 106 SP1 G120

Revise the *2012 Standard Specifications* as follows:

P**age 1-49, Subarticle 106-1(B) Domestic Steel, lines 2-7,** replace the first paragraph with the following:

All steel and iron products that are permanently incorporated into this project shall be produced in the United States except minimal amounts of foreign steel and iron products may be used provided the combined material cost of the items involved does not exceed 0.1% of the total amount bid for the entire project or $2,500, whichever is greater. If invoices showing the cost of the material are not provided, the amount of the bid item involving the foreign material will be used for calculations. This minimal amount of foreign produced steel and iron products permitted for use is not applicable to high strength fasteners. Domestically produced high strength fasteners are required.

MAINTENANCE OF THE PROJECT:

(11-20-07) (Rev. 1-17-12) 104-10 SP1 G125

Revise the *2012 Standard Specifications* as follows:

Page 1-35, Article 104-10 Maintenance of the Project, line 25, add the following after the first sentence of the first paragraph:

All guardrail/guiderail within the project limits shall be included in this maintenance.

Page 1-35, Article 104-10 Maintenance of the Project, line 30, add the following as the last sentence of the first paragraph:

The Contractor shall perform weekly inspections of guardrail and guiderail and shall report damages to the Engineer on the same day of the weekly inspection. *Where damaged guardrail or guiderail is repaired or replaced as a result of maintaining the project in* accordance with this article, such repair or replacement shall be performed within 7 consecutive calendar days of such inspection report.

Page 1-35, Article 104-10 Maintenance of the Project, lines 42-44, replace the last sentence of the last paragraph with the following:

The Contractor will not be directly compensated for any maintenance operations necessary, except for maintenance of guardrail/guiderail, as this work will be considered incidental to the work covered by the various contract items. The provisions of Article 104-7, Extra Work, and Article 104-8, Compensation and Record Keeping will apply to authorized maintenance of guardrail/guiderail. Performance of weekly inspections of guardrail/guiderail, and the damage reports required as described above, will be considered to be an incidental part of the work being paid for by the various contract items.

TWELVE MONTH GUARANTEE:

(7-15-03) 108 SP1 G145

(A) The Contractor shall guarantee materials and workmanship against latent and patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve months following the date of final acceptance of the work for maintenance and shall replace such defective materials and workmanship without cost to the Department. The Contractor will not be responsible for damage due to faulty design, normal wear and tear, for negligence on the part of the Department, and/or for use in excess of the design.

(B) Where items of equipment or material carry a manufacturer's guarantee for any period in excess of twelve months, then the manufacturer's guarantee shall apply for that particular piece of equipment or material. The Department's first remedy shall be through the manufacturer although the Contractor is responsible for invoking the warranted repair work with the manufacturer. The Contractor's responsibility shall be limited to the term of the manufacturer's guarantee. NCDOT would be afforded the same warranty as provided by the Manufacturer.

This guarantee provision shall be invoked only for major components of work in which the Contractor would be wholly responsible for under the terms of the contract. Examples would include pavement structures, bridge components, and sign structures. This provision will not be used as a mechanism to force the Contractor to return to the project to make repairs or perform additional work that the Department would normally compensate the Contractor for. In addition, routine maintenance activities (i.e. mowing grass, debris removal, ruts in earth shoulders,) are not parts of this guarantee.

Appropriate provisions of the payment and/or performance bonds shall cover this guarantee for the project.

To ensure uniform application statewide the Division Engineer will forward details regarding the circumstances surrounding any proposed guarantee repairs to the Chief Engineer for review and approval prior to the work being performed.

OUTSOURCING OUTSIDE THE USA:
(9-21-04) (Rev. 5-16-06) SP1 G150

All work on consultant contracts, services contracts, and construction contracts shall be performed in the United States of America. No work shall be outsourced outside of the United States of America.

Outsourcing for the purpose of this provision is defined as the practice of subcontracting labor, work, services, staffing, or personnel to entities located outside of the United States.

The North Carolina Secretary of Transportation shall approve exceptions to this provision in writing.

GIFTS FROM VENDORS AND CONTRACTORS:
(12-15-09) 107-1 SP1 G152

By Executive Order 24, issued by Governor Perdue, and *N.C.G.S.§ 133-32,* it is unlawful for any vendor or contractor (i.e. architect, bidder, contractor, construction manager, design professional, engineer, landlord, offeror, seller, subcontractor, supplier, or vendor), to make gifts or to give favors to any State employee of the Governor's Cabinet Agencies (i.e. Administration, Commerce, Correction, Crime Control and Public Safety, Cultural Resources, Environment and Natural Resources, Health and Human Services, Juvenile Justice and Delinquency Prevention, Revenue, Transportation, and the Office of the Governor). This prohibition covers those vendors and contractors who:

(A) Have a contract with a governmental agency; or
(B) Have performed under such a contract within the past year; or
(C) Anticipate bidding on such a contract in the future.

For additional information regarding the specific requirements and exemptions, vendors and contractors are encouraged to review Executive Order 24 and *N.C.G.S. § 133-32*.

Executive Order 24 also encouraged and invited other State Agencies to implement the requirements and prohibitions of the Executive Order to their agencies. Vendors and contractors should contact other State Agencies to determine if those agencies have adopted Executive Order 24.

LIABILITY INSURANCE:
(5-20-14) SP1 G160

Revise the *2012 Standard Specifications* as follows:

Page 1-60, Article 107-15 LIABILITY INSURANCE, line 16, add the following as the second sentence of the third paragraph:

Prior to beginning services, all contractors shall provide proof of coverage issued by a workers' compensation insurance carrier, or a certificate of compliance issued by the

Department of Insurance for self-insured subcontractors, irrespective of whether having regularly in service fewer than three employees.

EROSION AND SEDIMENT CONTROL/STORMWATER CERTIFICATION:

(1-16-07) (Rev 9-18-12) 105-16, 225-2, 16 SP1 G180

General

Schedule and conduct construction activities in a manner that will minimize soil erosion and the resulting sedimentation and turbidity of surface waters. Comply with the requirements herein regardless of whether or not a National Pollution discharge Elimination System (NPDES) permit for the work is required.

Establish a chain of responsibility for operations and subcontractors' operations to ensure that the *Erosion and Sediment Control/Stormwater Pollution Prevention Plan* is implemented and maintained over the life of the contract.

(A) *Certified Supervisor* - Provide a certified Erosion and Sediment Control/Stormwater Supervisor to manage the Contractor and subcontractor operations, insure compliance with Federal, State and Local ordinances and regulations, and manage the Quality Control Program.

(B) *Certified Foreman* - Provide a certified, trained foreman for each construction operation that increases the potential for soil erosion or the possible sedimentation and turbidity of surface waters.

(C) *Certified Installer* - Provide a certified installer to install or direct the installation for erosion or sediment/stormwater control practices.

(D) *Certified Designer* - Provide a certified designer for the design of the erosion and sediment control/stormwater component of reclamation plans and, if applicable, for the design of the project erosion and sediment control/stormwater plan.

Roles and Responsibilities

(A) *Certified Erosion and Sediment Control/Stormwater Supervisor* - The Certified Supervisor shall be Level II and responsible for ensuring the erosion and sediment control/stormwater plan is adequately implemented and maintained on the project and for conducting the quality control program. The Certified Supervisor shall be on the project within 24 hours notice from initial exposure of an erodible surface to the project's final acceptance. Perform the following duties:

(1) Manage Operations - Coordinate and schedule the work of subcontractors so that erosion and sediment control/stormwater measures are fully executed for each operation and in a timely manner over the duration of the contract.

(a) Oversee the work of subcontractors so that appropriate erosion and sediment control/stormwater preventive measures are conformed to at each stage of the work.

(b) Prepare the required National Pollutant Discharge Elimination System (NPDES) Inspection Record and submit to the Engineer.

(c) Attend all weekly or monthly construction meetings to discuss the findings of the NPDES inspection and other related issues.

(d) Implement the erosion and sediment control/stormwater site plans requested.

(e) Provide any needed erosion and sediment control/stormwater practices for the Contractor's temporary work not shown on the plans, such as, but not limited to work platforms, temporary construction, pumping operations, plant and storage yards, and cofferdams.

(f) Acquire applicable permits and comply with requirements for borrow pits, dewatering, and any temporary work conducted by the Contractor in jurisdictional areas.

(g) Conduct all erosion and sediment control/stormwater work in a timely and workmanlike manner.

(h) Fully perform and install erosion and sediment control/stormwater work prior to any suspension of the work.

(i) Coordinate with Department, Federal, State and Local Regulatory agencies on resolution of erosion and sediment control/stormwater issues due to the Contractor's operations.

(j) Ensure that proper cleanup occurs from vehicle tracking on paved surfaces or any location where sediment leaves the Right-of-Way.

(k) Have available a set of erosion and sediment control/stormwater plans that are initialed and include the installation date of Best Management Practices. These practices shall include temporary and permanent groundcover and be properly updated to reflect necessary plan and field changes for use and review by Department personnel as well as regulatory agencies.

(2) Requirements set forth under the NPDES Permit - The Department's NPDES Stormwater permit (NCS000250) outlines certain objectives and management measures pertaining to construction activities. The permit references *NCG010000, General Permit to Discharge Stormwater* under the NPDES, and states that the Department shall incorporate the applicable requirements into its delegated Erosion and Sediment Control Program for construction activities disturbing one or more acres of land. The Department further incorporates these requirements on all contracted bridge and culvert work at jurisdictional waters, regardless of size. Some of the requirements are, but are not limited to:

(a) Control project site waste to prevent contamination of surface or ground waters of the state, i.e. from equipment operation/maintenance, construction materials, concrete washout, chemicals, litter, fuels, lubricants, coolants, hydraulic fluids, any other petroleum products, and sanitary waste.

(b) Inspect erosion and sediment control/stormwater devices and stormwater discharge outfalls at least once every 7 calendar days, twice weekly for construction related *Federal Clean Water Act, Section 303(d)* impaired streams with turbidity violations, and within

24 hours after a significant rainfall event of 0.5 inch that occurs within a 24 hour period.

(c) Maintain an onsite rain gauge or use the Department's Multi-Sensor Precipitation Estimate website to maintain a daily record of rainfall amounts and dates.

(d) Maintain erosion and sediment control/stormwater inspection records for review by Department and Regulatory personnel upon request.

(e) Implement approved reclamation plans on all borrow pits, waste sites and staging areas.

(f) Maintain a log of turbidity test results as outlined in the Department's Procedure for Monitoring Borrow Pit Discharge.

(g) Provide secondary containment for bulk storage of liquid materials.

(h) Provide training for employees concerning general erosion and sediment control/stormwater awareness, the Department's NPDES Stormwater Permit NCS000250 requirements, and the applicable requirements of the *General Permit, NCG010000*.

(i) Report violations of the NPDES permit to the Engineer immediately who will notify the Division of Water Quality Regional Office within 24 hours of becoming aware of the violation.

(3) Quality Control Program - Maintain a quality control program to control erosion, prevent sedimentation and follow provisions/conditions of permits. The quality control program shall:

(a) Follow permit requirements related to the Contractor and subcontractors' construction activities.

(b) Ensure that all operators and subcontractors on site have the proper erosion and sediment control/stormwater certification.

(c) Notify the Engineer when the required certified erosion and sediment control/stormwater personnel are not available on the job site when needed.

(d) Conduct the inspections required by the NPDES permit.

(e) Take corrective actions in the proper timeframe as required by the NPDES permit for problem areas identified during the NPDES inspections.

(f) Incorporate erosion control into the work in a timely manner and stabilize disturbed areas with mulch/seed or vegetative cover on a section-by-section basis.

(g) Use flocculants approved by state regulatory authorities where appropriate and where required for turbidity and sedimentation reduction.

(h) Ensure proper installation and maintenance of temporary erosion and sediment control devices.

(i) Remove temporary erosion or sediment control devices when they are no longer necessary as agreed upon by the Engineer.

(j) The Contractor's quality control and inspection procedures shall be subject to review by the Engineer. Maintain NPDES inspection records and make records available at all times for verification by the Engineer.

(B) *Certified Foreman* - At least one Certified Foreman shall be onsite for each type of work listed herein during the respective construction activities to control erosion, prevent sedimentation and follow permit provisions:

(1) Foreman in charge of grading activities
(2) Foreman in charge of bridge or culvert construction over jurisdictional areas
(3) Foreman in charge of utility activities

The Contractor may request to use the same person as the Level II Supervisor and Level II Foreman. This person shall be onsite whenever construction activities as described above are taking place. This request shall be approved by the Engineer prior to work beginning.

The Contractor may request to name a single Level II Foreman to oversee multiple construction activities on small bridge or culvert replacement projects. This request shall be approved by the Engineer prior to work beginning.

(C) *Certified Installers* - Provide at least one onsite, Level I Certified Installer for each of the following erosion and sediment control/stormwater crew:

(1) Seeding and Mulching
(2) Temporary Seeding
(3) Temporary Mulching
(4) Sodding
(5) Silt fence or other perimeter erosion/sediment control device installations
(6) Erosion control blanket installation
(7) Hydraulic tackifier installation
(8) Turbidity curtain installation
(9) Rock ditch check/sediment dam installation
(10) Ditch liner/matting installation
(11) Inlet protection
(12) Riprap placement
(13) Stormwater BMP installations (such as but not limited to level spreaders, retention/detention devices)
(14) Pipe installations within jurisdictional areas

If a Level I *Certified Installer* is not onsite, the Contractor may substitute a Level II Foreman for a Level I Installer, provided the Level II Foreman is not tasked to another crew requiring Level II Foreman oversight.

(D) *Certified Designer* - Include the certification number of the Level III Certified Designer on the erosion and sediment control/stormwater component of all reclamation plans and if applicable, the certification number of the Level III Certified Designer on the design of the project erosion and sediment control/stormwater plan.

Preconstruction Meeting

Furnish the names of the *Certified Erosion and Sediment Control/Stormwater Supervisor*, *Certified Foremen, Certified Installers* and *Certified Designer* and notify the Engineer of changes in certified personnel over the life of the contract within 2 days of change.

Ethical Responsibility

Any company performing work for the North Carolina Department of Transportation has the ethical responsibility to fully disclose any reprimand or dismissal of an employee resulting from improper testing or falsification of records.

Revocation or Suspension of Certification

Upon recommendation of the Chief Engineer to the certification entity, certification for *Supervisor*, *Certified Foremen*, *Certified Installers* and *Certified Designer* may be revoked or suspended with the issuance of an *Immediate Corrective Action (ICA), Notice of Violation (NOV),* or C*ease and Desist Order* for erosion and sediment control/stormwater related issues.

The Chief Engineer may recommend suspension or permanent revocation of certification due to the following:

(A) Failure to adequately perform the duties as defined within this certification provision.
(B) Issuance of an ICA, NOV, or Cease and Desist Order.
(C) Failure to fully perform environmental commitments as detailed within the permit conditions and specifications.
(D) Demonstration of erroneous documentation or reporting techniques.
(E) Cheating or copying another candidate's work on an examination.
(F) Intentional falsification of records.
(G) Directing a subordinate under direct or indirect supervision to perform any of the above actions.
(H) Dismissal from a company for any of the above reasons.
(I) Suspension or revocation of one's certification by another entity.

Suspension or revocation of a certification will be sent by certified mail to the certificant and the Corporate Head of the company that employs the certificant.

A certificant has the right to appeal any adverse action which results in suspension or permanent revocation of certification by responding, in writing, to the Chief Engineer within 10 calendar days after receiving notice of the proposed adverse action.

Chief Engineer
1536 Mail Service Center
Raleigh, NC 27699-1536

Failure to appeal within 10 calendar days will result in the proposed adverse action becoming effective on the date specified on the certified notice. Failure to appeal within the time specified will result in a waiver of all future appeal rights regarding the adverse action taken.

The certificant will not be allowed to perform duties associated with the certification during the appeal process.

The Chief Engineer will hear the appeal and make a decision within 7 days of hearing the appeal. Decision of the Chief Engineer will be final and will be made in writing to the certificant.

If a certification is temporarily suspended, the certificant shall pass any applicable written examination and any proficiency examination, at the conclusion of the specified suspension period, prior to having the certification reinstated.

Measurement and Payment

Certified Erosion and Sediment Control/Stormwater Supervisor, Certified Foremen, Certified Installers and *Certified Designer* will be incidental to the project for which no direct compensation will be made.

PROCEDURE FOR MONITORING BORROW PIT DISCHARGE:

(2-20-07) (Rev. 3-19-13) 105-16, 230, 801 SP1 G181

Water discharge from borrow pit sites shall not cause surface waters to exceed 50 NTUs (nephelometric turbidity unit) in streams not designated as trout waters and 10 NTUs in streams, lakes or reservoirs designated as trout waters. For lakes and reservoirs not designated as trout waters, the turbidity shall not exceed 25 NTUs. If the turbidity exceeds these levels due to natural background conditions, the existing turbidity level shall not be increased.

If during any operating day, the downstream water quality exceeds the standard, the Contractor shall do all of the following:

(A) Either cease discharge or modify the discharge volume or turbidity levels to bring the downstream turbidity levels into compliance, or

(B) Evaluate the upstream conditions to determine if the exceedance of the standard is due to natural background conditions. If the background turbidity measurements exceed the standard, operation of the pit and discharge can continue as long as the stream turbidity levels are not increased due to the discharge.

(C) Measure and record the turbidity test results (time, date and sampler) at all defined sampling locations 30 minutes after startup and at a minimum, one additional sampling of all sampling locations during that 24-hour period in which the borrow pit is discharging.

(D) Notify DWQ within 24 hours of any stream turbidity standard exceedances that are not brought into compliance.

During the Environmental Assessment required by Article 230-4 of the *2012 Standard Specifications*, the Contractor shall define the point at which the discharge enters into the State's surface waters and the appropriate sampling locations. Sampling locations shall include points upstream and downstream from the point at which the discharge enters these

waters. Upstream sampling location shall be located so that it is not influenced by backwater conditions and represents natural background conditions. Downstream sampling location shall be located at the point where complete mixing of the discharge and receiving water has occurred.

The discharge shall be closely monitored when water from the dewatering activities is introduced into jurisdictional wetlands. Any time visible sedimentation (deposition of sediment) on the wetland surface is observed, the dewatering activity will be suspended until turbidity levels in the stilling basin can be reduced to a level where sediment deposition does not occur. Staining of wetland surfaces from suspended clay particles, occurring after evaporation or infiltration, does not constitute sedimentation. No activities shall occur in wetlands that adversely affect the functioning of a wetland. Visible sedimentation will be considered an indication of possible adverse impacts on wetland use.

The Engineer will perform independent turbidity tests on a random basis. These results will be maintained in a log within the project records. Records will include, at a minimum, turbidity test results, time, date and name of sampler. Should the Department's test results exceed those of the Contractor's test results, an immediate test shall be performed jointly with the results superseding the previous test results of both the Department and the Contractor.

The Contractor shall use the *NCDOT Turbidity Reduction Options for Borrow Pits Matrix*, available at http://www.ncdot.gov/doh/operations/dp_chief_eng/roadside/fieldops/downloads/Files/TurbidityReductionOptionSheet.pdf to plan, design, construct, and maintain BMPs to address water quality standards. Tier I Methods include stilling basins which are standard compensatory BMPs. Other Tier I methods are noncompensatory and shall be used when needed to meet the stream turbidity standards. Tier II Methods are also noncompensatory and are options that may be needed for protection of rare or unique resources or where special environmental conditions exist at the site which have led to additional requirements being placed in the DWQ's 401 Certifications and approval letters, Isolated Wetland Permits, Riparian Buffer Authorization or a DOT Reclamation Plan's Environmental Assessment for the specific site. Should the Contractor exhaust all Tier I Methods on a site exclusive of rare or unique resources or special environmental conditions, Tier II Methods may be required by regulators on a case by case basis per supplemental agreement.

The Contractor may use cation exchange capacity (CEC) values from proposed site borings to plan and develop the bid for the project. CEC values exceeding 15 milliequivalents per 100 grams of soil may indicate a high potential for turbidity and should be avoided when dewatering into surface water is proposed.

No additional compensation for monitoring borrow pit discharge will be paid.

EMPLOYMENT:

(11-15-11) (Rev. 1-17-12) 108, 102 SP1 G184

Revise the *2012 Standard Specifications* as follows:

Page 1-20, Subarticle 102-15(O), delete and replace with the following:

(O) Failure to restrict a former Department employee as prohibited by Article 108-5.

Page 1-65, Article 108-5 Character of Workmen, Methods, and Equipment, line 32, delete all of line 32, the first sentence of the second paragraph and the first word of the second sentence of the second paragraph.

STATE HIGHWAY ADMINISTRATOR TITLE CHANGE:
(9-18-12) SP1 G185

Revise the *2012 Standard Specifications* as follows:

Replace all references to "State Highway Administrator" with "Chief Engineer".

SUBLETTING OF CONTRACT:
(11-18-2014) 108-6 SP1 G186

Revise the *2012 Standard Specifications* as follows:

Page 1-66, Article 108-6 Subletting of Contract, line 37, add the following as the second sentence of the first paragraph:

All requests to sublet work shall be submitted within 30 days of the date of availability or prior to expiration of 20% of the contract time, whichever date is later, unless otherwise approved by the Engineer.

Page 1-67, Article 108-6 Subletting of Contract, line 7, add the following as the second sentence of the fourth paragraph:

Purchasing materials for subcontractors is not included in the percentage of work required to be performed by the Contractor. If the Contractor sublets items of work but elects to purchase material for the subcontractor, the value of the material purchased will be included in the total dollar amount considered to have been sublet.

PROJECT SPECIAL PROVISIONS - ROADWAY

CLEARING AND GRUBBING - METHOD II:
(9-17-02) (Rev. 1-17-12) 200 SP2 R02A

Perform clearing on this project to the limits established by Method "II" shown on Standard Drawing No. 200.02 of the *2012 Roadway Standard Drawings*.

TEMPORARY DETOURS:
(8-15-00) (Rev. 11-19-13) 1101 SP2 R30A

Construct the temporary detours required on this project in accordance with the typical sections in the plans or as directed by the Engineer.

After the detours have served their purpose, remove the portions deemed unsuitable for use as a permanent part of the project as directed by the Engineer. Salvage and stockpile the aggregate base course removed from the detours at locations within the right of way, as directed by the Engineer, for removal by State Forces. Place pavement and earth material

removed from the detour in embankments or dispose of in waste areas furnished by the Contractor.

Pipe culverts removed from the detours remain the property of the Contractor. Pipe culverts that are removed will be measured and will be paid at the contract unit price per linear foot for *Pipe Removal*. Payment for the construction of the detours will be made at the contract unit prices for the various items involved.

No direct payment will be made for removing the aggregate base course, earth material and pavement, as the cost of same shall be included in the lump sum price bid for *Grading*. Such prices and payments will be full compensation for the work of removing, salvaging, and stockpiling aggregate base course; removing pipe culverts; and for placing earth material and pavement in embankments or disposing of earth material and pavement in waste areas.

SHOULDER AND FILL SLOPE MATERIAL:

(5-21-02) 235, 560 SP2 R45 A

Description

Perform the required shoulder and slope construction for this project in accordance with the applicable requirements of Section 560 and Section 235 of the *2012 Standard Specifications*.

Measurement and Payment

Where the material has been obtained from an authorized stockpile or from a borrow source and *Borrow Excavation* is not included in the contract, no direct payment will be made for this work, as the cost of this work will be part of the work being paid at the contract lump sum price for *Grading.* If *Borrow Excavation* is included in this contract and the material has been obtained from an authorized stockpile or from a borrow source, measurement and payment will be as provided in Section 230 of the *2012 Standard Specifications* for *Borrow Excavation*.

PIPE INSTALLATION:

(11-20-12) 300 SP3 R01

Revise the *2012 Standard Specifications* as follows:

Page 3-1, Article 300-2, Materials, line 23-24, replace sentence with:

Provide foundation conditioning geotextile in accordance with Section 1056 for Type 4 geotextile.

BRIDGE APPROACH FILLS:

(10-19-10) (Rev. 1-17-12) 422 SP4 R02

Description

Bridge approach fills include bridge approach fills for sub regional tier bridges and reinforced bridge approach fills. Construct bridge approach fills in accordance with the contract and Standard Drawing No. 422.10 or 422.11 of the *2012 Roadway Standard Drawings*. Define "geosynthetics" as geotextiles or geomembranes.

Materials

Refer to Division 10 of the *2012 Standard Specifications*.

Item	Section
Anchor Pins	1056-2
Geotextiles	1056
Portland Cement Concrete	1000
Select Material	1016
Subsurface Drainage Materials	1044
Wire Staples	1060-8(D)

For bridge approach fills for sub regional tier bridges, provide Type 1 geotextile for filtration geotextiles. For reinforced bridge approach fills, provide Type 5 geotextile for geotextile reinforcement and Type 1 geotextile and No. 78M stone for drains. Use Class B concrete for concrete pads.

Use Class III or V select material for reinforced bridge approach fills and only Class V select material (standard size No. 78M stone) for bridge approach fills for sub regional tier bridges. Provide PVC pipes, fittings and outlet pipes for subsurface drainage materials. For drains and PVC pipes behind end bents, use pipes with perforations that meet AASHTO M 278.

Use PVC, HDPE or linear low density polyethylene (LLDPE) geomembranes for reinforced bridge approach fills. For PVC geomembranes, provide grade PVC30 geomembranes that meet ASTM D7176. For HDPE and LLDPE geomembranes, use geomembranes with a nominal thickness of at least 30 mils that meet Geosynthetic Research Institute Standard Specifications GM13 or GM17, respectively. Handle and store geomembranes in accordance with Article 1056-2 of the *2012 Standard Specifications*. Provide material certifications for geomembranes in accordance with Article 1056-3 of the *2012 Standard Specifications*.

Construction Methods

Excavate as necessary for bridge approach fills in accordance with the contract. Notify the Engineer when foundation excavation is complete. Do not place geomembranes or filtration geotextiles until excavation dimensions and foundation material are approved. Attach geomembranes and filtration geotextiles to end bent cap back and wing walls with adhesives, tapes or other approved methods. Glue or weld geomembrane seams to prevent leakage.

For reinforced bridge approach fills, place geotextile reinforcement within 3" of locations shown in Standard Drawing No. 422.10 of the *2012 Roadway Standard Drawings* and in slight tension free of kinks, folds, wrinkles or creases. Install geotextile reinforcement with the orientation, dimensions and number of layers shown in Standard Drawing No. 422.10 of the *2012 Roadway Standard Drawings*. Place first layer of geotextile reinforcement directly on geomembranes with no void or material in between. Install geotextile reinforcement with the machine direction (MD) parallel to the roadway centerline. The MD is the direction of the length or long dimension of the geotextile roll. Do not splice or overlap geotextile reinforcement in the MD so seams are perpendicular to the roadway centerline. Wrap geotextile reinforcement at end bent cap back and wing walls as shown in Standard Drawing No. 422.10 of the *2012 Roadway Standard Drawings* and directed by the Engineer. Extend

geotextile reinforcement at least 4 ft back behind end bent cap back and wing walls into select material.

Overlap adjacent geotextiles at least 18" with seams oriented parallel to the roadway centerline. Hold geotextiles in place with wire staples or anchor pins as needed. Contact the Engineer when existing or future obstructions such as foundations, pavements, pipes, inlets or utilities will interfere with geosynthetics.

For reinforced bridge approach fills, construct one foot square drains consisting of 4" diameter continuous perforated PVC pipes surrounded by No. 78M stone wrapped in Type 1 geotextiles. Install drains in accordance with Standard Drawing No. 422.10 of the *2012 Roadway Standard Drawings*. For bridge approach fills for sub regional tier bridges, install 4" diameter continuous perforated PVC drain pipes in accordance with Standard Drawing No. 422.11 of the *2012 Roadway Standard Drawings*.

Use solvent cement to connect PVC pipes so joints do not leak. Connect perforated pipes to outlet pipes just behind wing walls. Provide drain pipes and drains with positive drainage towards outlets. Place pipe sleeves in or under wing walls for outlet pipes so positive drainage is maintained. Use sleeves that can withstand wing wall loads.

Place select material in 8" to 10" thick lifts. Use only hand operated compaction equipment to compact select material for bridge approach fills. Compact Class III select material in accordance with Subarticle 235-3(C) of the *2012 Standard Specifications*. Compact No. 78M stone with a vibratory compactor to the satisfaction of the Engineer. Do not displace or damage geosynthetics, drain pipes or drains when placing and compacting select material. End dumping directly on geosynthetics is not permitted. Do not operate heavy equipment on geosynthetics, drain pipes or drains until they are covered with at least 8" of select material. Replace any damaged geosynthetics, drain pipes or drains to the satisfaction of the Engineer.

Cover open ends of outlet pipes with rodent screens as shown in Standard Drawing No. 815.03 of the *2012 Roadway Standard Drawings*. Connect ends of outlet pipes to concrete pads or existing drainage structures as directed by the Engineer. Construct concrete pads with an Ordinary surface finish that meets Subarticle 825-6(B) of the *2012 Standard Specifications*.

Measurement and Payment

Reinforced Bridge Approach Fill, Station ____ will be paid at the contract lump sum price. The contract lump sum price for *Reinforced Bridge Approach Fill, Station* ____ will be full compensation for labor, tools, equipment and reinforced bridge approach fill materials, excavating, backfilling, hauling and removing excavated materials, compacting select material, connecting outlet pipes to existing drainage structures and supplying select materials, geosynthetics, drains, pipe sleeves and outlet components and any incidentals necessary to construct all reinforced bridge approach fills at each bridge.

Bridge Approach Fill - Sub Regional Tier, Station ____ will be paid at the contract lump sum price. The contract lump sum price for *Bridge Approach Fill - Sub Regional Tier, Station* ____ will be full compensation for labor, tools, equipment and bridge approach fill materials, excavating, backfilling, hauling and removing excavated materials, compacting No. 78M

stone, connecting outlet pipes to existing drainage structures and supplying No. 78M stone, filtration geotextiles, drain pipes, pipe sleeves and outlet components and any incidentals necessary to construct all bridge approach fills at each sub regional tier bridge.

Payment will be made under:

Pay Item	**Pay Unit**
Reinforced Bridge Approach Fill, Station 15+47.50 –L-	Lump Sum
Bridge Approach Fill - Sub Regional Tier, Station ____	Lump Sum

ASPHALT PAVEMENTS - SUPERPAVE:

(6-19-12) (Rev. 10-21-14) 605, 609, 610, 650, 660 SP6 R01

Revise the *2012 Standard Specifications* as follows:

Page 6-3, Article 605-7 APPLICATION RATES AND TEMPERATURES, replace this article, including Table 601-1, with the following:

Apply tack coat uniformly across the existing surface at target application rates shown in Table 605-1.

TABLE 605-1
APPLICATION RATES FOR TACK COAT

Existing Surface	**Target Rate (gal/sy)**
	Emulsified Asphalt
New Asphalt	0.04 ± 0.01
Oxidized or Milled Asphalt	0.06 ± 0.01
Concrete	0.08 ± 0.01

Apply tack coat at a temperature within the ranges shown in Table 605-2. Tack coat shall not be overheated during storage, transport or at application.

TABLE 605-2
APPLICATION TEMPERATURE FOR TACK COAT

Asphalt Material	**Temperature Range**
Asphalt Binder, Grade PG 64-22	350 - 400°F
Emulsified Asphalt, Grade RS-1H	130 - 160°F
Emulsified Asphalt, Grade CRS-1	130 - 160°F
Emulsified Asphalt, Grade CRS-1H	130 - 160°F
Emulsified Asphalt, Grade HFMS-1	130 - 160°F
Emulsified Asphalt, Grade CRS-2	130 - 160°F

Page 6-7, Article 609-3 FIELD VERIFICATION OF MIXTURE AND JOB MIX FORMULA ADJUSTMENTS, lines 35-37, delete the second sentence of the second paragraph.

Page 6-18, Article 610-1 DESCRIPTION, lines 40-41, delete the last sentence of the last paragraph.

Page 6-19, Subarticle 610-3(A) Mix Design-General, line 5, add the following as the first paragraph:

Warm mix asphalt (WMA) is allowed for use at the Contractor's option in accordance with the NCDOT Approved Products List for WMA Technologies available at:

https://connect.ncdot.gov/resources/Materials/MaterialsResources/Warm%20Mix%20Asphalt%20Approved%20List.pdf

Page 6-21, Subarticle 610-3(C) Job Mix Formula (JMF), replace Table 610-1 with the following:

TABLE 610-1
DESIGN MIXING TEMPERATURE AT THE ASPHALT PLANT[A]

Binder Grade	HMA JMF Temperature	WMA JMF Temperature Range
PG 64-22	300ºF	225 - 275ºF
PG 70-22	315ºF	240 - 290ºF
PG 76-22	335ºF	260 - 310ºF

A. The mix temperature, when checked in the truck at the roadway, shall be within plus 15º and minus 25º of the temperature specified on the JMF.

Page 6-21, Subarticle 610-3(C) Job Mix Formula (JMF), lines 4-6, delete first sentence of the second paragraph. Line 7, in the second sentence of the second paragraph, replace "275ºF" with "275ºF or greater."

Page 6-22, Article 610-4 WEATHER, TEMPERATURE AND SEASONAL LIMITATIONS FOR PRODUCING AND PLACING ASPHALT MIXTURES, lines 15-17, replace the second sentence of the first paragraph with the following:

Do not place asphalt material when the air or surface temperatures, measured at the location of the paving operation away from artificial heat, do not meet Table 610-5.

Page 6-23, Article 610-4 WEATHER, TEMPERATURE AND SEASONAL LIMITATIONS FOR PRODUCING AND PLACING ASPHALT MIXTURES, replace Table 610-5 with the following:

TABLE 610-5
PLACEMENT TEMPERATURES FOR ASPHALT

Asphalt Concrete Mix Type	Minimum Surface and Air Temperature
B25.0B, C	35°F
I19.0B, C, D	35°F
SF9.5A, S9.5B	40°F[A]
S9.5C, S12.5C	45°F[A]
S9.5D, S12.5D	50°F

A. For the final layer of surface mixes containing recycled asphalt shingles (RAS), the minimum surface and air temperature shall be 50ºF.

Page 6-26, Article 610-7 HAULING OF ASPHALT MIXTURE, lines 22-23, in the fourth sentence of the first paragraph replace "so as to overlap the top of the truck bed and" with "to".

Page 6-41, Subarticle 650-3(B) Mix Design Criteria, replace Table 650-1 with the following:

TABLE 650-1
OGAFC GRADATION CRITERIA

Sieve Size (mm)	*Type FC-1*	*Type FC-1 Modified*	*Type FC-2 Modified*
19.0	-	-	100
12.5	100	100	**80** - 100
9.50	75 - 100	75 - 100	55 - **80**
4.75	25 - 45	25 - 45	15 - **30**
2.36	5 - 15	5 - 15	5 - **15**
0.075	1.0 - 3.0	1.0 - 3.0	2.0 - 4.0

Page 6-50, Table 660-1 MATERIAL APPLICATION RATES AND TEMPERATURES, lines 1-2, replace Note A in Table 660-1 with the following:

A. Use No. 6M, No. 67, No. 5 and No. 78M aggregate for retreatment before an asphalt overlay on existing pavement based on the width of the cracks in the existing pavement. Choose No. 78M for sections of roadway where the average width of existing cracks is 1/4" or less in width, No. 67 for sections of roadway where the average width of existing cracks are 1/4" to 5/8" in width and choose No. 5 for sections of roadway where the existing crack widths are greater than 5/8".

ASPHALT PAVER - FIXED AND MOBILE STRING LINE:
(10-21-03) (Rev. 1-17-12) 610 SP6 R06B

A mobile string line consisting of a 30 to 40 foot long ski is required for the widening and resurfacing on this project. A fixed string line is required for the new pavement construction on this project.

ASPHALT BINDER CONTENT OF ASPHALT PLANT MIXES:
(11-21-00) (Rev. 7-17-12) 609 SP6 R15

The approximate asphalt binder content of the asphalt concrete plant mixtures used on this project will be as follows:

Asphalt Concrete Base Course	Type B 25.0__	4.4%
Asphalt Concrete Intermediate Course	Type I 19.0__	4.8%
Asphalt Concrete Surface Course	Type S 4.75A	6.8%
Asphalt Concrete Surface Course	Type SA-1	6.8%
Asphalt Concrete Surface Course	Type SF 9.5A	6.7%
Asphalt Concrete Surface Course	Type S 9.5__	6.0%
Asphalt Concrete Surface Course	Type S 12.5__	5.6%

The actual asphalt binder content will be established during construction by the Engineer within the limits established in the *2012 Standard Specifications.*

ASPHALT PLANT MIXTURES:
(7-1-95) 609 SP6 R20

Place asphalt concrete base course material in trench sections with asphalt pavement spreaders made for the purpose or with other equipment approved by the Engineer.

PRICE ADJUSTMENT - ASPHALT BINDER FOR PLANT MIX:
(11-21-00) 620 SP6 R25

Price adjustments for asphalt binder for plant mix will be made in accordance with Section 620 of the *2012 Standard Specifications.*

The base price index for asphalt binder for plant mix is **$ 578.85** per ton.

This base price index represents an average of F.O.B. selling prices of asphalt binder at supplier's terminals on **January 1, 2015**.

FINAL SURFACE TESTING NOT REQUIRED:
(5-18-04) (Rev. 5-15-12) 610 SP6 R45

Final surface testing is not required on this project.

GUARDRAIL ANCHOR UNITS, TYPE 350 (TL-3):
(4-20-04) (Rev. 2-17-15) 862 SP8 R65

Description

Furnish and install guardrail anchor units in accordance with the details in the plans, the applicable requirements of Section 862 of the *2012 Standard Specifications*, and at locations shown in the plans.

Materials

The Contractor may at his option, furnish any one of the guardrail anchor units or approved equal.

Guardrail anchor unit (X-Tension) as manufactured by:

Barrier Systems, Inc.
c/o Transportation Equipment Services Inc.
420 Boardwalk Dr.
Youngsville, NC 27596
Telephone: 877-499-8727

Guardrail anchor unit (ET-Plus) as manufactured by:

Trinity Industries, Inc.
2525 N. Stemmons Freeway
Dallas, Texas 75207
Telephone: 800-644-7976

The guardrail anchor unit (SKT 350) as manufactured by:

Road Systems, Inc.
3616 Old Howard County Airport
Big Spring, Texas 79720
Telephone: 915-263-2435

Prior to installation the Contractor shall submit to the Engineer:

(A) FHWA acceptance letter for each guardrail anchor unit certifying it meets the requirements of NCHRP Report 350, Test Level 3, in accordance with Article 106-2 of the *2012 Standard Specifications*.

(B) Certified working drawings and assembling instructions from the manufacturer for each guardrail anchor unit in accordance with Article 105-2 of the *2012 Standard Specifications*.

No modifications shall be made to the guardrail anchor unit without the express written permission from the manufacturer. Perform installation in accordance with the details in the plans, and details and assembling instructions furnished by the manufacturer.

Construction Methods

Guardrail end delineation is required on all approach and trailing end sections for both temporary and permanent installations. Guardrail end delineation consists of yellow reflective sheeting applied to the entire end section of the guardrail in accordance with Article 1088-3 of the *2012 Standard Specifications* and is incidental to the cost of the guardrail anchor unit.

Measurement and Payment

Measurement and payment will be made in accordance with Article 862-6 of the *2012 Standard Specifications*.

Payment will be made under:

Pay Item	**Pay Unit**
Guardrail Anchor Units, Type 350	Each

STREET SIGNS AND MARKERS AND ROUTE MARKERS:

(7-1-95) 900 SP9 R02

Move any existing street signs, markers, and route markers out of the construction limits of the project and install the street signs and markers and route markers so that they will be visible to the traveling public if there is sufficient right of way for these signs and markers outside of the construction limits.

Near the completion of the project and when so directed by the Engineer, move the signs and markers and install them in their proper location in regard to the finished pavement of the project.

Stockpile any signs or markers that cannot be relocated due to lack of right of way, or any signs and markers that will no longer be applicable after the construction of the project, at locations directed by the Engineer for removal by others.

The Contractor shall be responsible to the owners for any damage to any street signs and markers or route markers during the above described operations.

No direct payment will be made for relocating, reinstalling, and/or stockpiling the street signs and markers and route markers as such work shall be considered incidental to other work being paid for by the various items in the contract.

MATERIALS:

(2-21-12) (Rev. 3-17-15) 1000, 1002, 1005, 1024, 1050, 1056, 1074, 1078, 1080, 1081, 1086, 1084, 1087, 1092 SP10 R01

Revise the *2012 Standard Specifications* as follows:

Page 10-1, Article 1000-1, DESCRIPTION, lines 9-10, replace the last sentence of the first paragraph with the following:

Type IL, IP, IS or IT blended cement may be used instead of Portland cement.

Page 10-1, Article 1000-1, DESCRIPTION, line 14, add the following:

Use materials which do not produce a mottled appearance through rusting or other staining of the finished concrete surface.

Page 10-5, Table 1000-1, REQUIREMENTS FOR CONCRETE, replace with the following:

TABLE 1000-1
REQUIREMENTS FOR CONCRETE

Class of Concrete	Min. Comp. Strength at 28 days	Maximum Water-Cement Ratio				Consistency Max. Slump		Cement Content			
		Air-Entrained Concrete		Non Air-Entrained Concrete		Vibrated	Non-Vibrated	Vibrated		Non-Vibrated	
		Rounded Aggregate	Angular Aggregate	Rounded Aggregate	Angular Aggregate			Min.	Max.	Min.	Max.
Units	*psi*					*inch*	*inch*	*lb/cy*	*lb/cy*	*lb/cy*	*lb/cy*
AA	4,500	0.381	0.426	-	-	3.5	-	639	715	-	-
AA Slip Form	4,500	0.381	0.426	-	-	1.5	-	639	715	-	-
Drilled Pier	4,500	-	-	0.450	0.450	-	5-7 dry 7-9 wet	-	-	640	800
A	3,000	0.488	0.532	0.550	0.594	3.5	4	564	-	602	-
B	2,500	0.488	0.567	0.559	0.630	1.5 machine-placed 2.5 hand-placed	4	508	-	545	-
Sand Light-weight	4,500	-	0.420	-	-	4	-	715	-	-	-
Latex Modified	3,000 7 day	0.400	0.400	-	-	6	-	658	-	-	-
Flowable Fill excavatable	150 max. at 56 days	as needed	as needed	as needed	as needed	-	Flow-able	-	-	40	100
Flowable Fill non-excavatable	125	as needed	as needed	as needed	as needed	-	Flow-able	-	-	100	as needed
Pavement	4,500 design, field 650 flexural, design only	0.559	0.559	-	-	1.5 slip form 3.0 hand place	-	526	-	-	-
Precast	See Table 1077-1	as needed	as needed	-	-	6	as needed	as needed	as needed	as needed	as needed
Prestress	per contract	See Table 1078-1	See Table 1078-1	-	-	8	-	564	as needed	-	-

Page 10-1, Article 1000-2, MATERIALS, line 16; Page 10-8, Subarticle 1000-7(A), MATERIALS, line 8; and Page 10-18, Article 1002-2, MATERIALS, line 9, add the following to the table of item references:

Item	**Section**
Type IL Blended Cement	1024-1

Page 10-7, Table 1000-3, MAXIMUM WATER-CEMENTITIOUS MATERIAL RATIO, replace with the following:

Class of Concrete	Rounded Aggregate	Angular Aggregate
AA and AA Slip Form	.366	.410
A	.469	.512
B	.469	.545
Pavement	.538	.538

Page 10-7, Article 1000-5, HIGH EARLY STRENGTH PORTLAND CEMENT CONCRETE, lines 30-31, delete the second sentence of the third paragraph.

Page 10-23, Table 1005-1, AGGREGATE GRADATION-COARSE AGGREGATE, replace with the following:

TABLE 1005-1
AGGREGATE GRADATION - COARSE AGGREGATE

Std. Size #	Percentage of Total by Weight Passing											Remarks
	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#10	#16	#40	#200	
4	100	90-100	20-55	0-15	-	0-5	-	-	-	-	-	A	Asphalt Plant Mix
467M	100	95-100	-	35-70	-	0-30	0-5	-	-	-	-	A	Asphalt Plant Mix
5	-	100	90-100	20-55	0-10	0-5	-	-	-	-	-	A	AST, Sediment Control Stone
57	-	100	95-100	-	25-60	-	0-10	0-5	-	-	-	A	AST, Str. Concrete, Shoulder Drain, Sediment Control Stone
57M	-	100	95-100	-	25-45	-	0-10	0-5	-	-	-	A	AST, Concrete Pavement
6M	-	-	100	90-100	20-55	0-20	0-8	-	-	-	-	A	AST
67	-	-	100	90-100	-	20-55	0-10	0-5	-	-	-	A	AST, Str. Concrete, Asphalt Plant Mix
78M	-	-	-	100	98-100	75-100	20-45	0-15	-	-	-	A	Asphalt Plant Mix, AST, Str. Conc, Weep Hole Drains
14M	-	-	-	-	-	100	35-70	5-20	-	0-8	-	A	Asphalt Plant Mix, AST, Weep Hole Drains, Str. Concrete
9	-	-	-	-	-	100	85-100	10-40	-	0-10	-	A	AST
ABC	-	100	75-97	-	55-80	-	35-55	-	25-45	-	14-30	4-12[B]	Aggregate Base Course, Aggregate Stabilization
ABC (M)	-	100	75-100	-	45-79	-	20-40	-	0-25	-	-	0-12[B]	Maintenance Stabilization
Light-weight[C]	-	-	-	-	100	80-100	5-40	0-20	-	0-10	-	0-2.5	AST

A. See Subarticle 1005-4(A).
B. See Subarticle 1005-4(B).
C. For Lightweight Aggregate used in Structural Concrete, see Subarticle 1014-2(E)(6).

Page 10-46, Article 1024-1, PORTLAND CEMENT, line 33, add the following as the ninth paragraph:

Use Type IL blended cement that meets AASHTO M 240, except that the limestone content is limited to between 5 and 12% by weight and the constituents shall be interground. Class F fly ash can replace a portion of Type IL blended cement and shall be replaced as outlined in Subarticle 1000-4(I) for Portland cement. For mixes that contain cement with alkali content between 0.6% and 1.0% and for mixes that contain a reactive aggregate documented by the Department, use a pozzolan in the amount shown in Table 1024-1.

Page 10-47, Subarticle 1024-3(B), Approved Sources, lines 16-18, replace the second sentence of the second paragraph with the following:

Tests shall be performed by AASHTO's designated National Transportation Product Evaluation Program (NTPEP) laboratory for concrete admixture testing.

Page 10-65, Article 1050-1, GENERAL, line 41, replace the first sentence with the following:

All fencing material and accessories shall meet Section 106.

Page 10-73, Article 1056-1 DESCRIPTION, lines 7-8, delete the first sentence of the second paragraph and replace with the following:

Use geotextile fabrics that are on the NCDOT Approved Products List.

Page 10-73, Article 1056-2 HANDLING AND STORING, line 17, replace "mechanically stabilized earth (MSE) wall faces" with "temporary wall faces".

Page 10-74, TABLE 1056-1 GEOTEXTILE REQUIREMENTS, replace table with the following:

TABLE 1056-1
GEOTEXTILE REQUIREMENTS

Property	**Requirement (MARV[A])**					**Test Method**
	Type 1	**Type 2**	**Type 3[B]**	**Type 4**	**Type 5[C]**	
Typical Application	*Shoulder Drains*	*Under Rip Rap*	*Temporary Silt Fence*	*Soil Stabilization*	*Temporary Walls*	
Elongation (MD & CD)	≥ 50%	≥ 50%	≤ 25%	< 50%	< 50%	ASTM D4632
Grab Strength (MD & CD)	Table 1[D], Class 3	Table 1[D], Class 1	100 lb	Table 1[D], Class 3	-	ASTM D4632
Tear Strength (MD & CD)			-		-	ASTM D4533
Puncture Strength			-		-	ASTM D6241
Ultimate Tensile Strength (MD & CD)	-	-	-	-	2,400 lb/ft (unless required otherwise in the contract)	ASTM D4595
Permittivity	Table 2[D], 15% to 50% *in Situ* Soil Passing No. 200[E]		Table 7[D]	Table 5[D]	0.20 sec^{-1}	ASTM D4491
Apparent Opening Size					No. 30[E]	ASTM D4751
UV Stability (Retained Strength)					70%	ASTM D4355

A. MARV does not apply to elongation
B. Minimum roll width of 36" required
C. Minimum roll width of 13 ft required
D. AASHTO M 288
E. US Sieve No. per AASHTO M 92

Page 10-115, Subarticle 1074-7(B), Gray Iron Castings, lines 10-11, replace with the first two sentences with the following:

Supply gray iron castings meeting all facets of AASHTO M 306 excluding proof load. Proof load testing will only be required for new casting designs during the design process, and conformance to M306 loading (40,000 lbs.) will be required only when noted on the design documents.

Page 10-126, Table 1078-1, REQUIREMENTS FOR CONCRETE, replace with the following:

TABLE 1078-1
REQUIREMENTS FOR CONCRETE

Property	28 Day Design Compressive Strength 6,000 psi or less	28 Day Design Compressive Strength greater than 6,000 psi
Maximum Water/Cementitious Material Ratio	0.45	0.40
Maximum Slump without HRWR	3.5"	3.5"
Maximum Slump with HRWR	8"	8"
Air Content (upon discharge into forms)	5 + 2%	5 + 2%

Page 10-151, Article 1080-4 Inspection and Sampling, lines 18-22, replace (B), (C) and (D) with the following:

(B) At least 3 panels prepared as specified in 5.5.10 of AASHTO M 300, Bullet Hole Immersion Test.

(C) At least 3 panels of 4"x6"x1/4" for the Elcometer Adhesion Pull Off Test, ASTM D4541.

(D) A certified test report from an approved independent testing laboratory for the Salt Fog Resistance Test, Cyclic Weathering Resistance Test, and Bullet Hole Immersion Test as specified in AASHTO M 300.

(E) A certified test report from an approved independent testing laboratory that the product has been tested for slip coefficient and meets AASHTO M253, Class B.

Page 10-161, Subarticle 1081-1(A) Classifications, lines 29-33, delete first 3 sentences of the description for Type 2 and replace with the following:

Type 2 - A low-modulus, general-purpose adhesive used in epoxy mortar repairs. It may be used to patch spalled, cracked or broken concrete where vibration, shock or expansion and contraction are expected.

Page 10-162, Subarticle 1081-1(A) Classifications, lines 4-7, delete the second and third sentences of the description for Type 3A. **Lines 16-22,** delete Types 6A, 6B and 6C.

Page 10-162, Subarticle 1081-1(B) Requirements, lines 26-30, replace the second paragraph with the following:

For epoxy resin systems used for embedding dowel bars, threaded rods, rebar, anchor bolts and other fixtures in hardened concrete, the manufacturer shall submit test results showing that the bonding system will obtain 125% of the specified required yield strength of the fixture. Furnish certification that, for the particular bolt grade, diameter and embedment depth required, the anchor system will not fail by adhesive failure and that there is no

movement of the anchor bolt. For certification and anchorage, use 3,000 psi as the minimum Portland cement concrete compressive strength used in this test. Use adhesives that meet Section 1081.

List the properties of the adhesive on the container and include density, minimum and maximum temperature application, setting time, shelf life, pot life, shear strength and compressive strength.

Page 10-163, Table 1081-1 Properties of Mixed Epoxy Resin Systems, replace table with the following:

TABLE 1081-1
PROPERTIES OF MIXED EPOXY RESIN SYSTEMS

Property	Type 1	Type 2	Type 3	Type 3A	Type 4A	Type 4B	Type 5
Viscosity-Poises at 77°F ± 2°F	Gel	10-30	25-75	Gel	40-150	40-150	1-6
Spindle No.	-	3	4	--	4	4	2
Speed (RPM)	-	20	20	--	10	10	50
Pot Life (Minutes)	20-50	30-60	20-50	5-50	40-80	40-80	20-60
Minimum Tensile Strength at 7 days (psi)	1,500	2,000	4,000	4,000	1,500	1,500	4,000
Tensile Elongation at 7 days (%)	30 min.	30 min.	2-5	2-5	5-15	5-15	2-5
Min. Compressive Strength of 2". mortar cubes at 24 hours	3,000 (Neat)	4,000-	6,000-	6,000 (Neat)	3,000	3,000	6,000
Min. Compressive Strength of 2" mortar cubes at 7 days	5,000 (Neat)	-	-	-	-	5,000	-
Maximum Water Absorption (%)	1.5	1.0	1.0	1.5	1.0	1.0	1.0
Min. Bond Strength Slant Shear Test at 14 days (psi)	1,500	1,500	2,000	2,000	1,500	1,500	1,500

Page 10-164, Subarticle 1081-1(E) Prequalification, lines 31-33, replace the second sentence of the first paragraph with the following:

Manufacturers choosing to supply material for Department jobs must submit an application through the Value Management Unit with the following information for each type and brand name:

Page 10-164, Subarticle 1081-1(E)(3), line 37, replace this subarticle with the following:

(3) Type of the material in accordance with Articles 1081-1 and 1081-4,

Page 10-165, Subarticle 1081-1(E)(6), line 1, in the first sentence of the first paragraph replace "AASHTO M 237" with "the specifications".

Page 10-165, Subarticle 1081-1(E) Prequalification, line 9-10, delete the second sentence of the last paragraph.

Page 10-165, Subarticle 1081-1(F) Acceptance, line 14, in the first sentence of the first paragraph replace "Type 1" with "Type 3".

Page 10-169, Subarticle 1081-3(G) Anchor Bolt Adhesives, delete this subarticle.

Page 10-170, Article 1081-3 Hot Bitumen, line 9, add the following at the end of Section 1081:

1081-4 EPOXY RESIN ADHESIVE FOR BONDING TRAFFIC MARKINGS

(A) General

This section covers epoxy resin adhesive for bonding traffic markers to pavement surfaces.

(B) Classification

The types of epoxies and their uses are as shown below:

Type I – Rapid Setting, High Viscosity, Epoxy Adhesive. This type of adhesive provides rapid adherence to traffic markers to the surface of pavement.

Type II – Standard Setting, High Viscosity, Epoxy Adhesive. This type of adhesive is recommended for adherence of traffic markers to pavement surfaces when rapid set is not required.

Type III – Rapid Setting, Low Viscosity, Water Resistant, Epoxy Adhesive. This type of rapid setting adhesive, due to its low viscosity, is appropriate only for use with embedded traffic markers.

Type IV – Standard Set Epoxy for Blade Deflecting-Type Plowable Markers.

(C) Requirements

Epoxies shall conform to the requirements set forth in AASHTO M 237.

(D) Prequalification

Refer to Subarticle 1081-1(E).

(E) Acceptance

Refer to Subarticle 1081-1(F).

Page 10-173, Article 1084-2 STEEL SHEET PILES, lines 37-38, replace first paragraph with the following:

Steel sheet piles detailed for permanent applications shall be hot rolled and meet ASTM A572 or ASTM A690 unless otherwise required by the plans. Steel sheet piles shall be coated as required by the plans. Galvanized sheet piles shall be coated in accordance with Section 1076. Metallized sheet piles shall be metallized in accordance to the Project Special Provision "Thermal Sprayed Coatings (Metallization)" with an 8 mil, 99.9% aluminum alloy coating and a 0.5 mil seal coating. Any portion of the metallized sheet piling encased in concrete shall receive a barrier coat. The barrier coat shall be an approved waterborne coating with a low-viscosity which readily absorbs into the pores of the aluminum thermal sprayed coating. The waterborne coating shall be applied at a spreading rate that results in a theoretical 1.5 mil dry film thickness. The manufacturer shall issue a letter of certification that the resin chemistry of the waterborne coating is compatible with the 99.9% aluminum thermal sprayed alloy and suitable for tidal water applications.

Page 10-174, Subarticle 1086-1(B)(1) Epoxy, lines 18-24, replace this subarticle with the following:

The epoxy shall meet Article 1081-4.

The 2 types of epoxy adhesive which may be used are Type I, Rapid Setting, and Type II, Standard Setting. Use Type II when the pavement temperature is above 60°F or per the manufacturer's recommendations whichever is more stringent. Use Type I when the pavement temperature is between 50°F and 60°F or per the manufacturer's recommendations whichever is more stringent. Epoxy adhesive Type I, Cold Set, may be used to attach temporary pavement markers to the pavement surface when the pavement temperature is between 32°F and 50°F or per the manufacturer's recommendations whichever is more stringent.

Page 10-175, Subarticle 1086-2(E) Epoxy Adhesives, line 27, replace "Section 1081" with "Article 1081-4".

Page 10-177, Subarticle 1086-3(E) Epoxy Adhesives, line 22, replace "Section 1081" with "Article 1081-4".

Page 10-179, Subarticle 1087-4(A) Composition, lines 39-41, replace the third paragraph with the following:

All intermixed and drop-on glass beads shall not contain more than 75 ppm arsenic or 200 ppm lead.

Page 10-180, Subarticle 1087-4(B) Physical Characteristics, line 8, replace the second paragraph with the following:

All intermixed and drop-on glass beads shall comply with NCGS § 136-30.2 and 23 USC § 109(r).

Page 10-181, Subarticle 1087-7(A) Intermixed and Drop-on Glass Beads, line 24, add the following after the first paragraph:

Use X-ray Fluorescence for the normal sampling procedure for intermixed and drop-on beads, without crushing, to check for any levels of arsenic and lead. If any arsenic or lead is detected, the sample shall be crushed and repeat the test using X-ray Fluorescence. If the X-ray Fluorescence test shows more than a LOD of 5 ppm, test the beads using United States

Environmental Protection Agency Method 6010B, 6010C or 3052 for no more than 75 ppm arsenic or 200 ppm lead.

Page 10-204, Subarticle 1092-2(A) Performance and Test Requirements, replace **Table 1092-3 Minimum Coefficient of Retroreflection for NC Grade A** with the following:

TABLE 1092-3
MINIMUM COEFFICIENT OF RETROREFLECTION FOR NC GRADE A
(Candelas Per Lux Per Square Meter)

Observation Angle, degrees	Entrance Angle, degrees	White	Yellow	Green	Red	Blue	Fluorescent Yellow Green	Fluorescent Yellow
0.2	-4.0	525	395	52	95	30	420	315
0.2	30.0	215	162	22	43	10	170	130
0.5	-4.0	310	230	31	56	18	245	185
0.5	30.0	135	100	14	27	6	110	81
1.0	-4.0	**120**	60	8	16	3.6	64	48
1.0	30.0	45	34	4.5	9	2	36	27

SHOULDER AND SLOPE BORROW:

(3-19-13) 1019 SP10 R10

Use soil in accordance with Section 1019 of the *2012 Standard Specifications*. Use soil consisting of loose, friable, sandy material with a PI greater than 6 and less than 25 and a pH ranging from 5.5 to 7.0.

Soil with a pH ranging from 4.0 to 5.5 will be accepted without further testing if additional limestone is provided in accordance with the application rates shown in Table 1019-1A. Soil type is identified during the soil analysis. Soils with a pH above 7.0 require acidic amendments to be added. Submit proposed acidic amendments to the Engineer for review and approval. Soils with a pH below 4.0 or that do not meet the PI requirements shall not be used.

pH TEST RESULT	Sandy Soils Additional Rate (lbs. / Acre)	Silt Loam Soils Additional Rate (lbs. / Acre)	Clay Loam Soils Additional Rate (lbs. / Acre)
4.0 - 4.4	1,000	4,000	6,000
4.5 - 4.9	500	3,000	5,000
5.0 - 5.4	NA	2,000	4,000

Note: Limestone application rates shown in this table are in addition to the standard rate of 4000 lbs. / acre required for seeding and mulching.

No direct payment will be made for providing additional lime or acidic amendments for Ph adjustment.

GROUT PRODUCTION AND DELIVERY:
(3-17-15) 1003 SP10 R20

Revise the *2012 Standard Specifications* as follows:

Replace Section 1003 with the following:

SECTION 1003
GROUT PRODUCTION AND DELIVERY

1003-1 DESCRIPTION

This section addresses cement grout to be used for structures, foundations, retaining walls, concrete barriers, embankments, pavements and other applications in accordance with the contract. Produce non-metallic grout composed of Portland cement and water and at the Contractor's option or as required, aggregate and pozzolans. Include chemical admixtures as required or needed. Provide sand cement or neat cement grout as required. Define "sand cement grout" as grout with only fine aggregate and "neat cement grout" as grout without aggregate.

The types of grout with their typical uses are as shown below:

Type 1 – A cement grout with only a 3-day strength requirement and a fluid consistency that is typically used for filling subsurface voids.

Type 2 – A nonshrink grout with strength, height change and flow conforming to ASTM C1107 that is typically used for foundations, ground anchors and soil nails.

Type 3 – A nonshrink grout with high early strength and freeze-thaw durability requirements that is typically used in pile blockouts, grout pockets, shear keys, dowel holes and recesses for concrete barriers and structures.

Type 4 – A neat cement grout with low strength, a fluid consistency and high fly ash content that is typically used for slab jacking.

Type 5 – A low slump, low mobility sand cement grout with minimal strength that is typically used for compaction grouting.

1003-2 MATERIALS

Refer to Division 10.

Item	**Section**
Chemical Admixtures	1024-3
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Portland Cement	1024-1
Silica Fume	1024-7
Water	1024-4

Do not use grout that contains soluble chlorides or more than 1% soluble sulfate. At the Contractor's option, use an approved packaged grout instead of the materials above except for water. Use packaged grouts that are on the NCDOT Approved Products List.

Use admixtures for grout that are on the NCDOT Approved Products List or other admixtures in accordance with Subarticle 1024-3(E) except do not use concrete additives or unclassified or other admixtures in Type 4 or 5 grout. Use Class F fly ash for Type 4 grout and Type II Portland cement for Type 5 grout.

Use well graded rounded aggregate with a gradation, liquid limit (LL) and plasticity index (PI) that meet Table 1003-1 for Type 5 grout. Fly ash may be substituted for a portion of the fines in the aggregate. Do not use any other pozzolans in Type 5 grout.

TABLE 1003-1
AGGREGATE REQUIREMENTS FOR TYPE 5 GROUT

Gradation		**Maximum Liquid Limit**	**Maximum Plasticity Index**
Sieve Designation per AASHTO M 92	**Percentage Passing (% by weight)**		
3/8"	100	N/A	N/A
No. 4	70 – 95		
No. 8	50 – 90		
No. 16	30 – 80		
No. 30	25 – 70		
No. 50	20 – 50		
No. 100	15 – 40		
No. 200	10 – 30	25	10

1003-3 COMPOSITION AND DESIGN

When using an approved packaged grout, a grout mix design submittal is not required. Otherwise, submit proposed grout mix designs for each grout mix to be used in the work. Mixes for all grout shall be designed by a Certified Concrete Mix Design Technician or an Engineer licensed by the State of North Carolina. Mix proportions shall be determined by a testing laboratory approved by the Department. Base grout mix designs on laboratory trial batches that meet Table 1003-2 and this section. With permission, the Contractor may use a quantity of chemical admixture within the range shown on the current list of approved admixtures maintained by the Materials and Tests Unit.

Submit grout mix designs in terms of saturated surface dry weights on Materials and Tests Form 312U at least 35 days before proposed use. Adjust batch proportions to compensate for surface moisture contained in the aggregates at the time of batching. Changes in the saturated surface dry mix proportions will not be permitted unless revised grout mix designs have been submitted to the Engineer and approved.

Accompany Materials and Tests Form 312U with a listing of laboratory test results of compressive strength, density and flow or slump and if applicable, aggregate

gradation, durability and height change. List the compressive strength of at least three 2" cubes at the age of 3 and 28 days.

The Engineer will review the grout mix design for compliance with the contract and notify the Contractor as to its acceptability. Do not use a grout mix until written notice has been received. Acceptance of the grout mix design or use of approved packaged grouts does not relieve the Contractor of his responsibility to furnish a product that meets the contract. Upon written request from the Contractor, a grout mix design accepted and used satisfactorily on any Department project may be accepted for use on other projects.

Perform laboratory tests in accordance with the following test procedures:

Property	**Test Method**
Aggregate Gradation[A]	AASHTO T 27
Compressive Strength	AASHTO T 106
Density (Unit Weight)	AASHTO T 121, AASHTO T 133[B], ANSI/API RP[C] 13B-1[B] (Section 4, Mud Balance)
Durability	AASHTO T 161[D]
Flow	ASTM C939 (Flow Cone)
Height Change	ASTM C1090[E]
Slump	AASHTO T 119

A. Applicable to grout with aggregate.
B. Applicable to Neat Cement Grout.
C. American National Standards Institute/American Petroleum Institute Recommended Practice.
D. Procedure A (Rapid Freezing and Thawing in Water) required.
E. Moist room storage required.

1003-4 GROUT REQUIREMENTS

Provide grout types in accordance with the contract. Use grouts with properties that meet Table 1003-2. The compressive strength of the grout will be considered the average compressive strength test results of three 2" cubes at each age. Make cubes that meet AASHTO T 106 from the grout delivered for the work or mixed on-site. Make cubes at such frequencies as the Engineer may determine and cure them in accordance with AASHTO T 106.

TABLE 1003-2
GROUT REQUIREMENTS

Type of Grout	Minimum Compressive Strength at		Height Change at 28 days	Flow[A]/Slump[B]	Minimum Durability Factor
	3 days	28 days			
1	3,000 psi	–	–	10 – 30 sec	–
2	Table 1[C]			Fluid Consistency[C]	–
3	5,000 psi	–	0 – 0.2%	Per Accepted Grout Mix Design/ Approved Packaged Grout	80
4[D]	600 psi	1,500 psi	–	10 – 26 sec	–
5	–	500 psi	–	1 – 3"	–

A. Applicable to Type 1 through 4 grouts.
B. Applicable to Type 5 grout.
C. ASTM C1107.
D. Use Type 4 grout with proportions by volume of 1 part cement and 3 parts fly ash.

1003-5 TEMPERATURE REQUIREMENTS

When using an approved packaged grout, follow the manufacturer's instructions for grout and air temperature at the time of placement. Otherwise, the grout temperature at the time of placement shall be not less than 50°F nor more than 90°F. Do not place grout when the air temperature measured at the location of the grouting operation in the shade away from artificial heat is below 40°F.

1003-6 ELAPSED TIME FOR PLACING GROUT

Agitate grout continuously before placement. Regulate the delivery so the maximum interval between the placing of batches at the work site does not exceed 20 minutes. Place grout before exceeding the times in Table 1003-3. Measure the elapsed time as the time between adding the mixing water to the grout mix and placing the grout.

TABLE 1003-3
ELAPSED TIME FOR PLACING GROUT
(with continuous agitation)

Air or Grout Temperature, Whichever is Higher	Maximum Elapsed Time	
	No Retarding Admixture Used	Retarding Admixture Used
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
79°F or below	60 minutes	1 hr. 45 minutes

1003-7 MIXING AND DELIVERY

Use grout free of any lumps and undispersed cement. When using an approved packaged grout, mix grout in accordance with the manufacturer's instructions. Otherwise, comply with Articles 1000-8 through 1000-12 to the extent applicable for grout instead of concrete.

TEMPORARY TRAFFIC CONTROL DEVICES:
(1-17-12) 1105 SP11 R05

Revise the *2012 Standard Specifications* as follows:

Page 11-5, Article 1105-6 Measurement and Payment, add the following paragraph after line 24:

Partial payments will be made on each payment estimate based on the following: 50% of the contract lump sum price bid will be paid on the first monthly estimate and the remaining 50% of the contract lump sum price bid will be paid on each subsequent estimate based on the percent of the project completed.

STANDARD SPECIAL PROVISIONS

AVAILABILITY OF FUNDS – TERMINATION OF CONTRACTS
(5-20-08) Z-2

General Statute 143C-6-11. (h) Highway Appropriation is hereby incorporated verbatim in this contract as follows:

(h) Amounts Encumbered. – Transportation project appropriations may be encumbered in the amount of allotments made to the Department of Transportation by the Director for the estimated payments for transportation project contract work to be performed in the appropriation fiscal year. The allotments shall be multiyear allotments and shall be based on estimated revenues and shall be subject to the maximum contract authority contained in *General Statute 143C-6-11(c).* Payment for transportation project work performed pursuant to contract in any fiscal year other than the current fiscal year is subject to appropriations by the General Assembly. Transportation project contracts shall contain a schedule of estimated completion progress, and any acceleration of this progress shall be subject to the approval of the Department of Transportation provided funds are available. The State reserves the right to terminate or suspend any transportation project contract, and any transportation project contract shall be so terminated or suspended if funds will not be available for payment of the work to be performed during that fiscal year pursuant to the contract. In the event of termination of any contract, the contractor shall be given a written notice of termination at least 60 days before completion of scheduled work for which funds are available. In the event of termination, the contractor shall be paid for the work already performed in accordance with the contract specifications.

Payment will be made on any contract terminated pursuant to the special provision in accordance with Subarticle 108-13(E) of the *2012 Standard Specifications*.

NCDOT GENERAL SEED SPECIFICATION FOR SEED QUALITY
(5-17-11) Z-3

Seed shall be sampled and tested by the North Carolina Department of Agriculture and Consumer Services, Seed Testing Laboratory. When said samples are collected, the vendor shall supply an independent laboratory report for each lot to be tested. Results from seed so sampled shall be final. Seed not meeting the specifications shall be rejected by the Department of Transportation and shall not be delivered to North Carolina Department of Transportation warehouses. If seed has been delivered it shall be available for pickup and replacement at the supplier's expense.

Any re-labeling required by the North Carolina Department of Agriculture and Consumer Services, Seed Testing Laboratory, that would cause the label to reflect as otherwise specified herein shall be rejected by the North Carolina Department of Transportation.

Seed shall be free from seeds of the noxious weeds Johnsongrass, Balloonvine, Jimsonweed, Witchweed, Itchgrass, Serrated Tussock, Showy Crotalaria, Smooth Crotalaria, Sicklepod, Sandbur, Wild Onion, and Wild Garlic. Seed shall not be labeled with the above weed species on the seed analysis label. Tolerances as applied by the Association of Official Seed Analysts will NOT be allowed for the above noxious weeds except for Wild Onion and Wild Garlic.

Tolerances established by the Association of Official Seed Analysts will generally be recognized. However, for the purpose of figuring pure live seed, the found pure seed and found germination percentages as reported by the North Carolina Department of Agriculture and Consumer Services, Seed Testing Laboratory will be used. Allowances, as established by the NCDOT, will be recognized for minimum pure live seed as listed on the following pages.

The specifications for restricted noxious weed seed refers to the number per pound as follows:

Restricted Noxious Weed	Limitations per Lb. Of Seed	Restricted Noxious Weed	Limitations per Lb. of Seed
Blessed Thistle	4 seeds	Cornflower (Ragged Robin)	27 seeds
Cocklebur	4 seeds	Texas Panicum	27 seeds
Spurred Anoda	4 seeds	Bracted Plantain	54 seeds
Velvetleaf	4 seeds	Buckhorn Plantain	54 seeds
Morning-glory	8 seeds	Broadleaf Dock	54 seeds
Corn Cockle	10 seeds	Curly Dock	54 seeds
Wild Radish	12 seeds	Dodder	54 seeds
Purple Nutsedge	27 seeds	Giant Foxtail	54 seeds
Yellow Nutsedge	27 seeds	Horsenettle	54 seeds
Canada Thistle	27 seeds	Quackgrass	54 seeds
Field Bindweed	27 seeds	Wild Mustard	54 seeds
Hedge Bindweed	27 seeds		

Seed of Pensacola Bahiagrass shall not contain more than 7% inert matter, Kentucky Bluegrass, Centipede and Fine or Hard Fescue shall not contain more than 5% inert matter

whereas a maximum of 2% inert matter will be allowed on all other kinds of seed. In addition, all seed shall not contain more than 2% other crop seed nor more than 1% total weed seed. The germination rate as tested by the North Carolina Department of Agriculture shall not fall below 70%, which includes both dormant and hard seed. Seed shall be labeled with not more than 7%, 5% or 2% inert matter (according to above specifications), 2% other crop seed and 1% total weed seed.

Exceptions may be made for minimum pure live seed allowances when cases of seed variety shortages are verified. Pure live seed percentages will be applied in a verified shortage situation. Those purchase orders of deficient seed lots will be credited with the percentage that the seed is deficient.

FURTHER SPECIFICATIONS FOR EACH SEED GROUP ARE GIVEN BELOW:

Minimum 85% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 144 restricted noxious weed seed per pound. Seed less than 83% pure live seed will not be approved.

Sericea Lespedeza
Oats (seeds)

Minimum 80% pure live seed; maximum 1% total weed seed; maximum 2% total other crop; maximum 144 restricted noxious weed seed per pound. Seed less than 78% pure live seed will not be approved.

Tall Fescue (all approved varieties)
Kobe Lespedeza
Korean Lespedeza
Weeping Lovegrass
Carpetgrass
Bermudagrass
Browntop Millet
German Millet – Strain R
Clover – Red/White/Crimson

Minimum 78% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 144 restricted noxious weed seed per pound. Seed less than 76% pure live seed will not be approved.

Common or Sweet Sundangrass

Minimum 76% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 144 restricted noxious weed seed per pound. Seed less than 74% pure live seed will not be approved.

Rye (grain; all varieties)
Kentucky Bluegrass (all approved varieties)
Hard Fescue (all approved varieties)
Shrub (bicolor) Lespedeza

Minimum 70% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 144 noxious weed seed per pound. Seed less than 70% pure live seed will not be approved.

Centipedegrass
Crownvetch
Pensacola Bahiagrass
Creeping Red Fescue
Japanese Millet
Reed Canary Grass
Zoysia

Minimum 70% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 5% inert matter; maximum 144 restricted noxious weed seed per pound.

Barnyard Grass
Big Bluestem
Little Bluestem
Bristly Locust
Birdsfoot Trefoil
Indiangrass
Orchardgrass
Switchgrass
Yellow Blossom Sweet Clover

ERRATA
(1-17-12) (Rev. 11-18-14) Z-4

Revise the *2012 Standard Specifications* as follows:

Division 2

Page 2-7, line 31, Article 215-2 Construction Methods, replace "Article 107-26" with "Article 107-25".

Page 2-17, Article 226-3, Measurement and Payment, line 2, delete "pipe culverts,".

Page 2-20, Subarticle 230-4(B), Contractor Furnished Sources, change references as follows: Line 1, replace "(4) Buffer Zone" with "(c) Buffer Zone"; **Line 12,** replace "(5) Evaluation for Potential Wetlands and Endangered Species" with "(d) Evaluation for Potential Wetlands and Endangered Species"; and **Line 33,** replace "(6) Approval" with "(4) Approval".

Division 3

Page 3-1, after line 15, Article 300-2 Materials, replace "1032-9(F)" with "1032-6(F)".

Division 4

Page 4-77, line 27, Subarticle 452-3(C) Concrete Coping, replace "sheet pile" with "reinforcement".

Division 6

Page 6-7, line 31, Article 609-3 Field Verification of Mixture and Job Mix Formula Adjustments, replace "30" with "45".

Page 6-10, line 42, Subarticle 609-6(C)(2), replace "Subarticle 609-6(E)" with "Subarticle 609-6(D)".

Page 6-11, Table 609-1 Control Limits, replace "Max. Spec. Limit" for the Target Source of $P_{0.075}/P_{be}$ Ratio with "1.0".

Page 6-40, Article 650-2 Materials, replace "Subarticle 1012-1(F)" with "Subarticle 1012-1(E)"

Division 8

Page 8-23, line 10, Article 838-2 Materials, replace "Portland Cement Concrete, Class B" with "Portland Cement Concrete, Class A".

Division 10

Page 10-166, Article 1081-3 Hot Bitumen, replace "Table 1081-16" with "Table 1081-2", replace "Table 1081-17" with "Table 1081-3", and replace "Table 1081-18" with "Table 1081-4".

Division 12

Page 12-7, Table 1205-3, add "FOR THERMOPLASTIC" to the end of the title.
Page 12-8, Subarticle 1205-5(B), line 13, replace "Table 1205-2" with "Table 1205-4".
Page 12-8, Table 1205-4 and 1205-5, replace "THERMOPLASTIC" in the title of these tables with "POLYUREA".
Page 12-9, Subarticle 1205-6(B), line 21, replace "Table 1205-4" with "Table 1205-6".
Page 12-11, Subarticle 1205-8(C), line 25, replace "Table 1205-5" with "Table 1205-7".

Division 15

Page 15-4, Subarticle 1505-3(F) Backfilling, line 26, replace "Subarticle 235-4(C)" with "Subarticle 235-3(C)".
Page 15-6, Subarticle 1510-3(B), after line 21, replace the allowable leakage formula with the following: **$W=LD\sqrt{P} \div 148{,}000$**
Page 15-6, Subarticle 1510-3(B), line 32, delete "may be performed concurrently or" and replace with "shall be performed".
Page 15-17, Subarticle 1540-3(E), line 27, delete "Type 1".

Division 17

Page 17-26, line 42, Subarticle 1731-3(D) Termination and Splicing within Interconnect Center, delete this subarticle.

Revise the *2012 Roadway Standard Drawings* as follows:

1633.01 Sheet 1 of 1, English Standard Drawing for Matting Installation, replace "1633.01" with "1631.01".

PLANT AND PEST QUARANTINES

(Imported Fire Ant, Gypsy Moth, Witchweed, And Other Noxious Weeds)

(3-18-03) (Rev. 10-15-13) Z-04a

Within Quarantined Area

This project may be within a county regulated for plant and/or pests. If the project or any part of the Contractor's operations is located within a quarantined area, thoroughly clean all equipment prior to moving out of the quarantined area. Comply with federal/state regulations by obtaining a certificate or limited permit for any regulated article moving from the quarantined area.

Originating in a Quarantined County

Obtain a certificate or limited permit issued by the N.C. Department of Agriculture/United States Department of Agriculture. Have the certificate or limited permit accompany the article when it arrives at the project site.

Contact

Contact the N.C. Department of Agriculture/United States Department of Agriculture at 1-800-206-9333, 919-733-6932, or *http://www.ncagr.gov/plantind/* to determine those specific project sites located in the quarantined area or for any regulated article used on this project originating in a quarantined county.

Regulated Articles Include

1. Soil, sand, gravel, compost, peat, humus, muck, and decomposed manure, separately or with other articles. This includes movement of articles listed above that may be associated with cut/waste, ditch pulling, and shoulder cutting.
2. Plants with roots including grass sod.
3. Plant crowns and roots.
4. Bulbs, corms, rhizomes, and tubers of ornamental plants.
5. Hay, straw, fodder, and plant litter of any kind.
6. Clearing and grubbing debris.
7. Used agricultural cultivating and harvesting equipment.
8. Used earth-moving equipment.
9. Any other products, articles, or means of conveyance, of any character, if determined by an inspector to present a hazard of spreading imported fire ant, gypsy moth, witchweed or other noxious weeds.

MINIMUM WAGES
(7-21-09) Z-5

FEDERAL: The Fair Labor Standards Act provides that with certain exceptions every employer shall pay wages at the rate of not less than SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

STATE: The North Carolina Minimum Wage Act provides that every employer shall pay to each of his employees, wages at a rate of not less than SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

The minimum wage paid to all skilled labor employed on this contract shall be SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

The minimum wage paid to all intermediate labor employed on this contract shall be SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

The minimum wage paid to all unskilled labor on this contract shall be SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

This determination of the intent of the application of this act to the contract on this project is the responsibility of the Contractor.

The Contractor shall have no claim against the Department of Transportation for any changes in the minimum wage laws, Federal or State. It is the responsibility of the Contractor to keep fully informed of all Federal and State Laws affecting his contract.

ON-THE-JOB TRAINING
(10-16-07) (Rev. 5-21-13) Z-10

Description

The North Carolina Department of Transportation will administer a custom version of the Federal On-the-Job Training (OJT) Program, commonly referred to as the Alternate OJT Program. All contractors (existing and newcomers) will be automatically placed in the Alternate Program. Standard OJT requirements typically associated with individual projects will no longer be applied at the project level. Instead, these requirements will be applicable on an annual basis for each contractor administered by the OJT Program Manager.

On the Job Training shall meet the requirements of 23 CFR 230.107 (b), 23 USC – Section 140, this provision and the On-the-Job Training Program Manual.

The Alternate OJT Program will allow a contractor to train employees on Federal, State and privately funded projects located in North Carolina. However, priority shall be given to training employees on NCDOT Federal-Aid funded projects.

Minorities and Women

Developing, training and upgrading of minorities and women toward journeyman level status is a primary objective of this special training provision. Accordingly, the Contractor shall make every effort to enroll minority and women as trainees to the extent that such persons are available within a reasonable area of recruitment. This training commitment is not intended, and shall not be used, to discriminate against any applicant for training, whether a member of a minority group or not.

Assigning Training Goals

The Department, through the OJT Program Manager, will assign training goals for a calendar year based on the contractors' past three years' activity and the contractors' anticipated upcoming year's activity with the Department. At the beginning of each year, all contractors eligible will be contacted by the Department to determine the number of trainees that will be assigned for the upcoming calendar year. At that time the Contractor shall enter into an agreement with the Department to provide a self-imposed on-the-job training program for the calendar year. This agreement will include a specific number of annual training goals agreed to by both parties. The number of training assignments may range from 1 to 15 per contractor per calendar year. The Contractor shall sign an agreement to fulfill their annual goal for the year. A sample agreement is available at www.ncbowd.com/section/on-the-job-training.

Training Classifications

The Contractor shall provide on-the-job training aimed at developing full journeyman level workers in the construction craft/operator positions. Preference shall be given to providing training in the following skilled work classifications:

Equipment Operators	Office Engineers
Truck Drivers	Estimators
Carpenters	Iron / Reinforcing Steel Workers
Concrete Finishers	Mechanics
Pipe Layers	Welders

The Department has established common training classifications and their respective training requirements that may be used by the contractors. However, the classifications established are not all-inclusive. Where the training is oriented toward construction applications, training will be allowed in lower-level management positions such as office engineers and estimators. Contractors shall submit new classifications for specific job functions that their employees are performing. The Department will review and recommend for acceptance to FHWA the new classifications proposed by contractors, if applicable. New classifications shall meet the following requirements:

Proposed training classifications are reasonable and realistic based on the job skill classification needs, and

The number of training hours specified in the training classification is consistent with common practices and provides enough time for the trainee to obtain journeyman level status.

The Contractor may allow trainees to be trained by a subcontractor provided that the Contractor retains primary responsibility for meeting the training and this provision is made applicable to the subcontract. However, only the Contractor will receive credit towards the annual goal for the trainee.

Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. The number of trainees shall be distributed among the work classifications on the basis of the contractor's needs and the availability of journeymen in the various classifications within a reasonable area of recruitment.

No employee shall be employed as a trainee in any classification in which they have successfully completed a training course leading to journeyman level status or in which they have been employed as a journeyman.

Records and Reports

The Contractor shall maintain enrollment, monthly and completion reports documenting company compliance under these contract documents. These documents and any other information as requested shall be submitted to the OJT Program Manager.

Upon completion and graduation of the program, the Contractor shall provide each trainee with a certification Certificate showing the type and length of training satisfactorily completed.

Trainee Interviews

All trainees enrolled in the program will receive an initial and Trainee/Post graduate interview conducted by the OJT program staff.

Trainee Wages

Contractors shall compensate trainees on a graduating pay scale based upon a percentage of the prevailing minimum journeyman wages (Davis-Bacon Act). Minimum pay shall be as follows:

60 percent	of the journeyman wage for the first half of the training period
75 percent	of the journeyman wage for the third quarter of the training period
90 percent	of the journeyman wage for the last quarter of the training period

In no instance shall a trainee be paid less than the local minimum wage. The Contractor shall adhere to the minimum hourly wage rate that will satisfy both the NC Department of Labor (NCDOL) and the Department.

Achieving or Failing to Meet Training Goals

The Contractor will be credited for each trainee employed by him on the contract work who is currently enrolled or becomes enrolled in an approved program and who receives training for at least 50 percent of the specific program requirement. Trainees will be allowed to be transferred between projects if required by the Contractor's scheduled workload to meet training goals.

If a contractor fails to attain their training assignments for the calendar year, they may be taken off the NCDOT's Bidders List.

Measurement and Payment

No compensation will be made for providing required training in accordance with these contract documents.

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	17BP.7.R.37	1	17

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

STRUCTURE SUBSURFACE INVESTIGATION

PROJ. REFERENCE NO. *17BP.7.R.37* F.A. PROJ. _____

COUNTY *GUILFORD*

PROJECT DESCRIPTION *DIVISION 7 GROUP E*
17BP BRIDGE REPLACEMENTS

SITE DESCRIPTION *BRIDGE NO. 238 OVER LITTLE ALAMANCE CREEK ON STATE ROUTE 1005 (ALAMANCE CHURCH ROAD)*

CONTENTS

SHEET	DESCRIPTION
1	TITLE SHEET
2 -2A	LEGEND
3	BORING LOCATION DIAGRAM
4 - 17	BORE LOG REPORTS, CORE LOG REPORTS AND ROCK CORE PHOTOGRAPHS

PERSONNEL
W. DUGGINS
T. BARTLETT
J. MANKE
D. CORLEY

INVESTIGATED BY *TERRACON CONSULTANTS*

CHECKED BY *D. CORLEY*

SUBMITTED BY *TERRACON CONSULTANTS*

DATE *OCTOBER 2012*

CAUTION NOTICE

THE SUBSURFACE INFORMATION AND THE SUBSURFACE INVESTIGATION ON WHICH IT IS BASED WERE MADE FOR THE PURPOSE OF STUDY, PLANNING, AND DESIGN, AND NOT FOR CONSTRUCTION OR PAY PURPOSES. THE VARIOUS FIELD BORING LOGS, ROCK CORES, AND SOIL TEST DATA AVAILABLE MAY BE REVIEWED OR INSPECTED IN RALEIGH BY CONTACTING THE N. C. DEPARTMENT OF TRANSPORTATION, GEOTECHNICAL ENGINEERING UNIT AT (919) 707-6850. NEITHER THE SUBSURFACE PLANS AND REPORTS, NOR THE FIELD BORING LOGS, ROCK CORES, OR SOIL TEST DATA ARE PART OF THE CONTRACT.

GENERAL SOIL AND ROCK STRATA DESCRIPTIONS AND INDICATED BOUNDARIES ARE BASED ON A GEOTECHNICAL INTERPRETATION OF ALL AVAILABLE SUBSURFACE DATA AND MAY NOT NECESSARILY REFLECT THE ACTUAL SUBSURFACE CONDITIONS BETWEEN BORINGS OR BETWEEN SAMPLED STRATA WITHIN THE BOREHOLE. THE LABORATORY SAMPLE DATA AND THE IN SITU (IN-PLACE) TEST DATA CAN BE RELIED ON ONLY TO THE DEGREE OF RELIABILITY INHERENT IN THE STANDARD TEST METHOD. THE OBSERVED WATER LEVELS OR SOIL MOISTURE CONDITIONS INDICATED IN THE SUBSURFACE INVESTIGATIONS ARE AS RECORDED AT THE TIME OF THE INVESTIGATION. THESE WATER LEVELS OR SOIL MOISTURE CONDITIONS MAY VARY CONSIDERABLY WITH TIME ACCORDING TO CLIMATIC CONDITIONS INCLUDING TEMPERATURES, PRECIPITATION, AND WIND, AS WELL AS OTHER NON-CLIMATIC FACTORS.

THE BIDDER OR CONTRACTOR IS CAUTIONED THAT DETAILS SHOWN ON THE SUBSURFACE PLANS ARE PRELIMINARY ONLY AND IN MANY CASES THE FINAL DESIGN DETAILS ARE DIFFERENT. FOR BIDDING AND CONSTRUCTION PURPOSES, REFER TO THE CONSTRUCTION PLANS AND DOCUMENTS FOR FINAL DESIGN INFORMATION ON THIS PROJECT. THE DEPARTMENT DOES NOT WARRANT OR GUARANTEE THE SUFFICIENCY OR ACCURACY OF THE INVESTIGATION MADE, NOR THE INTERPRETATIONS MADE, OR OPINION OF THE DEPARTMENT AS TO THE TYPE OF MATERIALS AND CONDITIONS TO BE ENCOUNTERED. THE BIDDER OR CONTRACTOR IS CAUTIONED TO MAKE SUCH INDEPENDENT SUBSURFACE INVESTIGATIONS AS HE DEEMS NECESSARY TO SATISFY HIMSELF AS TO CONDITIONS TO BE ENCOUNTERED ON THIS PROJECT. THE CONTRACTOR SHALL HAVE NO CLAIM FOR ADDITIONAL COMPENSATION OR FOR AN EXTENSION OF TIME FOR ANY REASON RESULTING FROM THE ACTUAL CONDITIONS ENCOUNTERED AT THE SITE DIFFERING FROM THOSE INDICATED IN THE SUBSURFACE INFORMATION.

NOTE - THE INFORMATION CONTAINED HEREIN IS NOT IMPLIED OR GUARANTEED BY THE N. C. DEPARTMENT OF TRANSPORTATION AS BEING ACCURATE NOR IT IS CONSIDERED TO BE PART OF THE PLANS, SPECIFICATIONS, OR CONTRACT FOR THE PROJECT.

NOTE - BY HAVING REQUESTED THIS INFORMATION THE CONTRACTOR SPECIFICALLY WAIVES ANY CLAIMS FOR INCREASED COMPENSATION OR EXTENSION OF TIME BASED ON DIFFERENCES BETWEEN THE CONDITIONS INDICATED HEREIN AND THE ACTUAL CONDITIONS AT THE PROJECT SITE.

DRAWN BY: *J. MANKE*

Terracon
2020 STARITA ROAD, SUITE E CHARLOTTE, NC 28206
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NORTH CAROLINA PROFESSIONAL SEAL 034441 ENGINEER JONATHAN P. MANKE
10-31-12

PROJECT REFERENCE NO.	SHEET NO.
17BP.7.R.37	2

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT
SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

SOIL DESCRIPTION

SOIL IS CONSIDERED TO BE THE UNCONSOLIDATED, SEMI-CONSOLIDATED, OR WEATHERED EARTH MATERIALS THAT CAN BE PENETRATED WITH A CONTINUOUS FLIGHT POWER AUGER, AND YIELD LESS THAN 100 BLOWS PER FOOT ACCORDING TO STANDARD PENETRATION TEST (AASHTO T206, ASTM D-1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY SHALL INCLUDE: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. EXAMPLE:

VERY STIFF, GRAY, SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6

SOIL LEGEND AND AASHTO CLASSIFICATION

GENERAL CLASS.	GRANULAR MATERIALS (≤ 35% PASSING #200)							SILT-CLAY MATERIALS (> 35% PASSING #200)				ORGANIC MATERIALS		
GROUP CLASS.	A-1		A-3	A-2				A-4	A-5	A-6	A-7	A-1, A-2 A-3	A-4, A-5 A-6, A-7	
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6			
SYMBOL														
% PASSING #10 #40 #200	50 MX 30 MX 15 MX		50 MX 25 MX	51 MN 10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN	GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
LIQUID LIMIT PLASTIC INDEX	6 MX		NP	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN	SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS
GROUP INDEX	0		0	0	4 MX			8 MX	12 MX	16 MX	No MX			
USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS. GRAVEL, AND SAND		FINE SAND	SILTY OR CLAYEY GRAVEL AND SAND				SILTY SOILS		CLAYEY SOILS				
GEN. RATING AS A SUBGRADE	EXCELLENT TO GOOD							FAIR TO POOR				FAIR TO POOR	POOR	UNSUITABLE

PI OF A-7-5 SUBGROUP IS ≤ LL - 30 ; PI OF A-7-6 SUBGROUP IS > LL - 30

CONSISTENCY OR DENSENESS

PRIMARY SOIL TYPE	COMPACTNESS OR CONSISTENCY	RANGE OF STANDARD PENETRATION RESISTENCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH ($TONS/FT^2$)
GENERALLY GRANULAR MATERIAL (NON-COHESIVE)	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	<4 4 TO 10 10 TO 30 30 TO 50 >50	N/A
GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	<2 2 TO 4 4 TO 8 8 TO 15 15 TO 30 >30	<0.25 0.25 TO 0.50 0.5 TO 1.0 1 TO 2 2 TO 4 >4

TEXTURE OR GRAIN SIZE

U.S. STD. SIEVE SIZE	4	10	40	60	200	270
OPENING (MM)	4.76	2.00	0.42	0.25	0.075	0.053

BOULDER (BLDR.)	COBBLE (COB.)	GRAVEL (GR.)	COARSE SAND (CSE. SD.)	FINE SAND (F SD.)	SILT (SL.)	CLAY (CL.)

GRAIN SIZE	MM	305	75	2.0	0.25	0.05	0.005
	IN.	12	3				

SOIL MOISTURE - CORRELATION OF TERMS

SOIL MOISTURE SCALE (ATTERBERG LIMITS)	FIELD MOISTURE DESCRIPTION	GUIDE FOR FIELD MOISTURE DESCRIPTION
	- SATURATED - (SAT.)	USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE
LL — LIQUID LIMIT		
PLASTIC RANGE (PI)	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE
PL — PLASTIC LIMIT		
OM — OPTIMUM MOISTURE	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE
SL — SHRINKAGE LIMIT		
	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE

PLASTICITY

	PLASTICITY INDEX (PI)	DRY STRENGTH
NONPLASTIC	0-5	VERY LOW
LOW PLASTICITY	6-15	SLIGHT
MED. PLASTICITY	16-25	MEDIUM
HIGH PLASTICITY	26 OR MORE	HIGH

COLOR

DESCRIPTIONS MAY INCLUDE COLOR OR COLOR COMBINATIONS (TAN, RED, YELLOW-BROWN, BLUE-GRAY). MODIFIERS SUCH AS LIGHT, DARK, STREAKED, ETC. ARE USED TO DESCRIBE APPEARANCE.

GRADATION

WELL GRADED - INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE.
UNIFORM - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE. (ALSO POORLY GRADED)
GAP-GRADED - INDICATES A MIXTURE OF UNIFORM PARTICLES OF TWO OR MORE SIZES.

ANGULARITY OF GRAINS

THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS IS DESIGNATED BY THE TERMS ANGULAR, SUBANGULAR, SUBROUNDED, OR ROUNDED.

MINERALOGICAL COMPOSITION

MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHENEVER THEY ARE CONSIDERED OF SIGNIFICANCE.

COMPRESSIBILITY

SLIGHTLY COMPRESSIBLE	LIQUID LIMIT LESS THAN 31
MODERATELY COMPRESSIBLE	LIQUID LIMIT EQUAL TO 31-50
HIGHLY COMPRESSIBLE	LIQUID LIMIT GREATER THAN 50

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%
MODERATELY ORGANIC	5 - 10%	12 - 20%
HIGHLY ORGANIC	>10%	>20%

OTHER MATERIAL	
TRACE	1 - 10%
LITTLE	10 - 20%
SOME	20 - 35%
HIGHLY	35% AND ABOVE

GROUND WATER

- WATER LEVEL IN BORE HOLE IMMEDIATELY AFTER DRILLING
- STATIC WATER LEVEL AFTER 24 HOURS
- PW — PERCHED WATER, SATURATED ZONE, OR WATER BEARING STRATA
- SPRING OR SEEP

MISCELLANEOUS SYMBOLS

- ROADWAY EMBANKMENT (RE) WITH SOIL DESCRIPTION
- SOIL SYMBOL
- ARTIFICIAL FILL (AF) OTHER THAN ROADWAY EMBANKMENT
- INFERRED SOIL BOUNDARY
- INFERRED ROCK LINE
- ALLUVIAL SOIL BOUNDARY
- 25/025 — DIP & DIP DIRECTION OF ROCK STRUCTURES
- SPT, DPT, DMT, VST, PMT — TEST BORING
- AUGER BORING
- CORE BORING
- MW — MONITORING WELL
- PIEZOMETER INSTALLATION
- SLOPE INDICATOR INSTALLATION
- CONE PENETROMETER TEST
- SOUNDING ROD
- TEST BORING W/ CORE
- SPT N-VALUE
- REF — SPT REFUSAL

ABBREVIATIONS

AR - AUGER REFUSAL
BT - BORING TERMINATED
CL. - CLAY
CPT - CONE PENETRATION TEST
CSE. - COARSE
DMT - DILATOMETER TEST
DPT - DYNAMIC PENETRATION TEST
e - VOID RATIO
F - FINE
FOSS. - FOSSILIFEROUS
FRAC. - FRACTURED, FRACTURES
FRAGS. - FRAGMENTS
HI. - HIGHLY
MED. - MEDIUM
MICA. - MICACEOUS
MOD. - MODERATELY
NP - NON PLASTIC
ORG. - ORGANIC
PMT - PRESSUREMETER TEST
SAP. - SAPROLITIC
SD. - SAND, SANDY
SL. - SILT, SILTY
SLI. - SLIGHTLY
TCR - TRICONE REFUSAL
w - MOISTURE CONTENT
V - VERY
VST - VANE SHEAR TEST
WEA. - WEATHERED
γ - UNIT WEIGHT
γ_d - DRY UNIT WEIGHT

SAMPLE ABBREVIATIONS
S - BULK
SS - SPLIT SPOON
ST - SHELBY TUBE
RS - ROCK
RT - RECOMPACTED TRIAXIAL
CBR - CALIFORNIA BEARING RATIO

EQUIPMENT USED ON SUBJECT PROJECT

DRILL UNITS:
- [ ] MOBILE B- ___
- [ ] BK-51
- [ ] CME-45C
- [ ] CME-550
- [ ] PORTABLE HOIST
- [X] DIEDRICH D50
- [ ] _____

ADVANCING TOOLS:
- [ ] CLAY BITS
- [ ] 6" CONTINUOUS FLIGHT AUGER
- [X] 8" HOLLOW AUGERS
- [ ] HARD FACED FINGER BITS
- [ ] TUNG.-CARBIDE INSERTS
- [ ] CASING [ ] W/ ADVANCER
- [ ] TRICONE _____" STEEL TEETH
- [X] TRICONE 3-7/8" TUNG.-CARB.
- [ ] CORE BIT
- [ ] _____

HAMMER TYPE:
- [X] AUTOMATIC [ ] MANUAL

CORE SIZE:
- [ ] -B_____
- [X] -N Q2
- [ ] -H_____

HAND TOOLS:
- [ ] POST HOLE DIGGER
- [ ] HAND AUGER
- [ ] SOUNDING ROD
- [ ] VANE SHEAR TEST
- [ ] _____

REVISED 09/23/09

PROJECT REFERENCE NO.	SHEET NO.
17BP.7.R.37	2A

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT
SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

ROCK DESCRIPTION

HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT IF TESTED, WOULD YIELD SPT REFUSAL. AN INFERRED ROCK LINE INDICATES THE LEVEL AT WHICH NON-COASTAL PLAIN MATERIAL WOULD YIELD SPT REFUSAL. SPT REFUSAL IS PENETRATION BY A SPLIT SPOON SAMPLER EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS. IN NON-COASTAL PLAIN MATERIAL, THE TRANSITION BETWEEN SOIL AND ROCK IS OFTEN REPRESENTED BY A ZONE OF WEATHERED ROCK.
ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:

WEATHERED ROCK (WR)		NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.
CRYSTALLINE ROCK (CR)		FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.
NON-CRYSTALLINE ROCK (NCR)		FINE TO COARSE GRAIN METAMORPHIC AND NON-COASTAL PLAIN SEDIMENTARY ROCK THAT WOULD YEILD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES PHYLLITE, SLATE, SANDSTONE, ETC.
COASTAL PLAIN SEDIMENTARY ROCK (CP)		COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.

WEATHERING

FRESH	ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.
VERY SLIGHT (V SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED, SOME JOINTS MAY SHOW THIN CLAY COATINGS IF OPEN, CRYSTALS ON A BROKEN SPECIMEN FACE SHINE BRIGHTLY. ROCK RINGS UNDER HAMMER BLOWS IF OF A CRYSTALLINE NATURE.
SLIGHT (SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED AND DISCOLORATION EXTENDS INTO ROCK UP TO 1 INCH. OPEN JOINTS MAY CONTAIN CLAY. IN GRANITOID ROCKS SOME OCCASIONAL FELDSPAR CRYSTALS ARE DULL AND DISCOLORED. CRYSTALLINE ROCKS RING UNDER HAMMER BLOWS.
MODERATE (MOD.)	SIGNIFICANT PORTIONS OF ROCK SHOW DISCOLORATION AND WEATHERING EFFECTS. IN GRANITOID ROCKS, MOST FELDSPARS ARE DULL AND DISCOLORED, SOME SHOW CLAY. ROCK HAS DULL SOUND UNDER HAMMER BLOWS AND SHOWS SIGNIFICANT LOSS OF STRENGTH AS COMPARED WITH FRESH ROCK.
MODERATELY SEVERE (MOD. SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. IN GRANITOID ROCKS, ALL FELDSPARS DULL AND DISCOLORED AND A MAJORITY SHOW KAOLINIZATION. ROCK SHOWS SEVERE LOSS OF STRENGTH AND CAN BE EXCAVATED WITH A GEOLOGIST'S PICK. ROCK GIVES "CLUNK" SOUND WHEN STRUCK. *IF TESTED, WOULD YIELD SPT REFUSAL*
SEVERE (SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC CLEAR AND EVIDENT BUT REDUCED IN STRENGTH TO STRONG SOIL. IN GRANITOID ROCKS ALL FELDSPARS ARE KAOLINIZED TO SOME EXTENT. SOME FRAGMENTS OF STRONG ROCK USUALLY REMAIN. *IF TESTED, YIELDS SPT N VALUES > 100 BPF*
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT THE MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE SUCH THAT ONLY MINOR VESTIGES OF THE ORIGINAL ROCK FABRIC REMAIN. *IF TESTED, YIELDS SPT N VALUES < 100 BPF*
COMPLETE	ROCK REDUCED TO SOIL. ROCK FABRIC NOT DISCERNIBLE, OR DISCERNIBLE ONLY IN SMALL AND SCATTERED CONCENTRATIONS. QUARTZ MAY BE PRESENT AS DIKES OR STRINGERS. SAPROLITE IS ALSO AN EXAMPLE.

ROCK HARDNESS

VERY HARD	CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.
HARD	CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.
MODERATELY HARD	CAN BE SCRATCHED BY KNIFE OR PICK. GOUGES OR GROOVES TO 0.25 INCHES DEEP CAN BE EXCAVATED BY HARD BLOW OF A GEOLOGIST'S PICK. HAND SPECIMENS CAN BE DETACHED BY MODERATE BLOWS.
MEDIUM HARD	CAN BE GROOVED OR GOUGED 0.05 INCHES DEEP BY FIRM PRESSURE OF KNIFE OR PICK POINT. CAN BE EXCAVATED IN SMALL CHIPS TO PEICES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGIST'S PICK.
SOFT	CAN BE GROVED OR GOUGED READILY BY KNIFE OR PICK. CAN BE EXCAVATED IN FRAGMENTS FROM CHIPS TO SEVERAL INCHES IN SIZE BY MODERATE BLOWS OF A PICK POINT. SMALL, THIN PIECES CAN BE BROKEN BY FINGER PRESSURE.
VERY SOFT	CAN BE CARVED WITH KNIFE. CAN BE EXCAVATED READILY WITH POINT OF PICK. PIECES 1 INCH OR MORE IN THICKNESS CAN BE BROKEN BY FINGER PRESSURE. CAN BE SCRATCHED READILY BY FINGERNAIL.

FRACTURE SPACING

TERM	SPACING
VERY WIDE	MORE THAN 10 FEET
WIDE	3 TO 10 FEET
MODERATELY CLOSE	1 TO 3 FEET
CLOSE	0.16 TO 1 FEET
VERY CLOSE	LESS THAN 0.16 FEET

BEDDING

TERM	THICKNESS
VERY THICKLY BEDDED	> 4 FEET
THICKLY BEDDED	1.5 - 4 FEET
THINLY BEDDED	0.16 - 1.5 FEET
VERY THINLY BEDDED	0.03 - 0.16 FEET
THICKLY LAMINATED	0.008 - 0.03 FEET
THINLY LAMINATED	< 0.008 FEET

INDURATION

FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF THE MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.

FRIABLE	RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.
MODERATELY INDURATED	GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.
INDURATED	GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.
EXTREMELY INDURATED	SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.

TERMS AND DEFINITIONS

ALLUVIUM (ALLUV.) - SOILS THAT HAVE BEEN TRANSPORTED BY WATER.

AQUIFER - A WATER BEARING FORMATION OR STRATA.

ARENACEOUS - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND.

ARGILLACEOUS - APPLIED TO ALL ROCKS OR SUBSTANCES COMPOSED OF CLAY MINERALS, OR HAVING A NOTABLE PROPORTION OF CLAY IN THEIR COMPOSITION, AS SHALE, SLATE, ETC.

ARTESIAN - GROUND WATER THAT IS UNDER SUFFICIENT PRESSURE TO RISE ABOVE THE LEVEL AT WHICH IT IS ENCOUNTERED, BUT WHICH DOES NOT NECESSARILY RISE TO OR ABOVE THE GROUND SURFACE.

CALCAREOUS (CALC.) - SOILS THAT CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE.

COLLUVIUM - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE.

CORE RECOVERY (REC.) - TOTAL LENGTH OF ALL MATERIAL RECOVERED IN THE CORE BARREL DIVIDED BY TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.

DIKE - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK.

DIP - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL.

DIP DIRECTION (DIP AZIMUTH) - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH.

FAULT - A FRACTURE OR FRACTURE ZONE ALONG WHICH THERE HAS BEEN DISPLACEMENT OF THE SIDES RELATIVE TO ONE ANOTHER PARALLEL TO THE FRACTURE.

FISSILE - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES.

FLOAT - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLODGED FROM PARENT MATERIAL.

FLOOD PLAIN (FP) - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM.

FORMATION (FM.) - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD.

JOINT - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED.

LEDGE - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT.

LENS - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS.

MOTTLED (MOT.) - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS. MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE.

PERCHED WATER - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM.

RESIDUAL (RES.) SOIL - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK.

ROCK QUALITY DESIGNATION (RQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.

SAPROLITE (SAP.) - RESIDUAL SOIL THAT RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK.

SILL - AN INTRUSIVE BODY OF IGNEOUS ROCK OF APPROXIMATELY UNIFORM THICKNESS AND RELATIVELY THIN COMPARED WITH ITS LATERAL EXTENT, THAT HAS BEEN EMPLACED PARALLEL TO THE BEDDING OR SCHISTOSITY OF THE INTRUDED ROCKS.

SLICKENSIDE - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE.

STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT) - NUMBER OF BLOWS (N OR BPF) OF A 140 LB. HAMMER FALLING 30 INCHES REQUIRED TO PRODUCE A PENETRATION OF 1 FOOT INTO SOIL WITH A 2 INCH OUTSIDE DIAMETER SPLIT SPOON SAMPLER. SPT REFUSAL IS PENETRATION EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS.

STRATA CORE RECOVERY (SREC.) - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE.

STRATA ROCK QUALITY DESIGNATION (SRQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS WITHIN A STRATUM EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF STRATA AND EXPRESSED AS A PERCENTAGE.

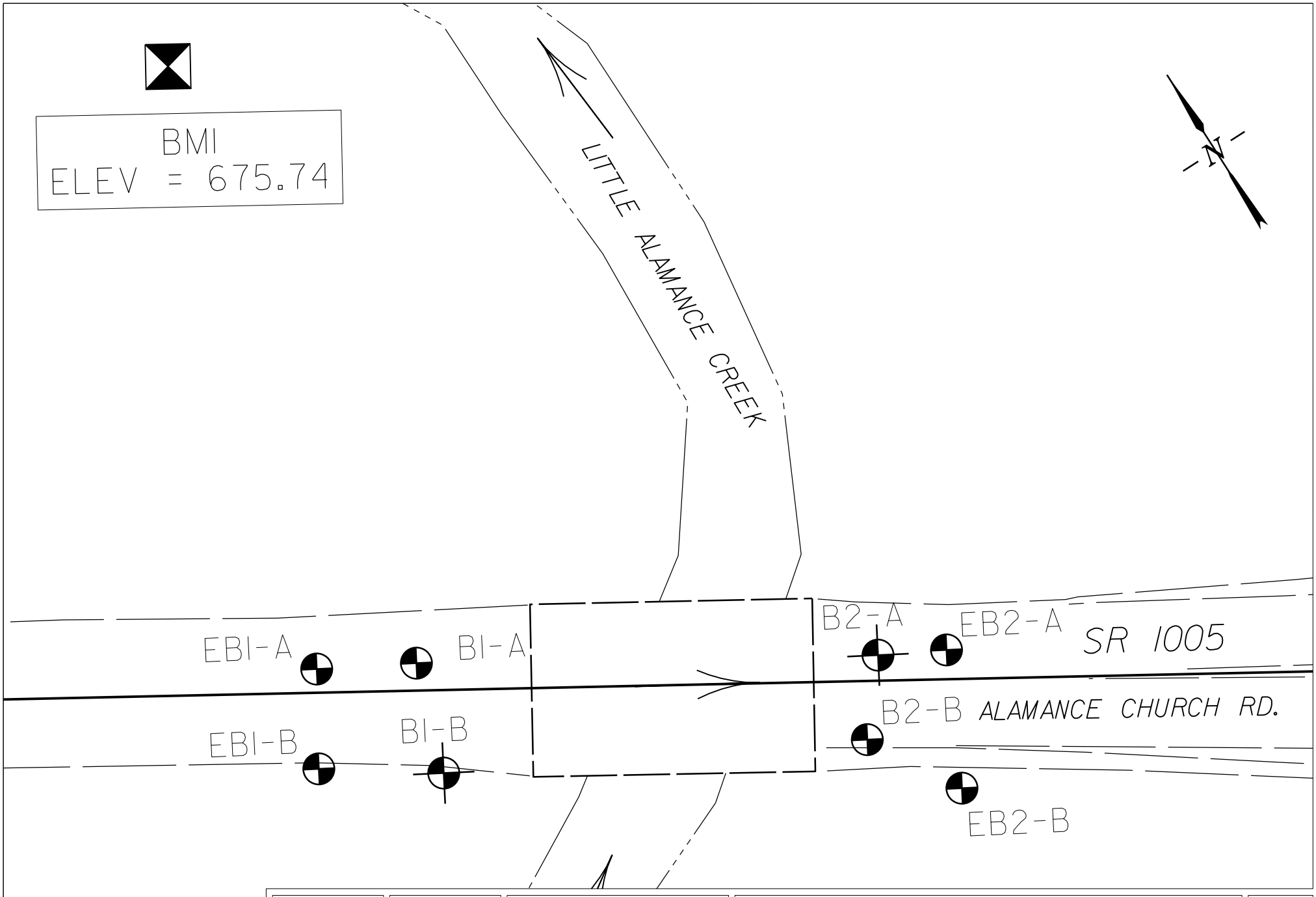
TOPSOIL (TS.) - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.

BENCH MARK: BM-1 (N: 829507, E: 1782592)

ELEVATION: 675.74 FT.

NOTES:
FIAD - FILLED IN AFTER DRILLING

REVISED 09/23/09



0 10 20
FEET

SCALE:	1 : 20
DATE:	OCT. 2012
DRAWN BY:	JPM
APPROVED BY:	DJC

PROJ. REFERENCE NUMBER:	17.BP.7.R.37
TIP NUMBER:	GROUP E
COUNTY:	GUILFORD
TERRACON PROJECT:	71115060

Terracon
2020 STARITA ROAD, SUITE E CHARLOTTE, NC 28206
PH. (704) 509-1777 FAX. (704) 509-1888

BORING LOCATION DIAGRAM

BRIDGE NO. 238 OVER LITTLE ALAMANCE CREEK
ON STATE ROUTE 1005 (ALAMANCE CHURCH RD)

SHEET
3

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. EB1-A	**STATION** 11+98	**OFFSET** 4 ft LT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 682.9 ft	**TOTAL DEPTH** 20.0 ft	**NORTHING** 829,413	**EASTING** 1,782,560	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
685										682.9 GROUND SURFACE	0.0
										682.0 Asphalt (0.9 ft)	0.9
										681.2 Concrete (0.8 ft)	1.7
680	679.4	3.5	4	3	4	7		M		**ROADWAY EMBANKMENT** Tan-orange sandy CLAY	
675	674.4	8.5	1	3	1	4		M		675.9 Red-brown sandy CLAY	7.0
670	669.4	13.5	8	10	9	19		M		670.9 **RESIDUAL** Tan silty SAND	12.0
665	664.4	18.5	100/0.5			100/0.5				666.9 **WEATHERED ROCK** (Tan-brown Metamorphosed Granite)	16.0
	662.9	20.0	60/0			60/0				662.9	20.0

Boring Terminated with Standard Penetration Test Refusal at Elevation 662.9 ft on Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-1/4" HSA to 20.0 feet.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/6/12

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. EB1-B	**STATION** 11+98	**OFFSET** 12 ft RT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 682.9 ft	**TOTAL DEPTH** 26.5 ft	**NORTHING** 829,399	**EASTING** 1,782,551	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic	
DRILLER Duggins, W.T.	**START DATE** 06/07/12	**COMP. DATE** 06/07/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
685										
										682.9 GROUND SURFACE 0.0
										ROADWAY EMBANKMENT Red-orange, sandy CLAY
680	679.4	3.5	WOH	WOH	WOH WOH	0		M		
675	674.4	8.5	WOH	1	WOH	1		M		
										670.9 12.0
670	669.4	13.5	8	19	24	43		W		Greenish-gray and white, silty SAND with gravel
665	664.4	18.5	60/0.1			60/0.1				664.4 18.5 **WEATHERED ROCK** (Gray and white Metamorphosed Granite)
660	659.4	23.5	100/0.3			100/0.3				
	656.4	26.5	60/0			60/0				656.4 26.5 Boring Terminated with Standard Penetration Test Refusal at Elevation 656.4 ft on Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-7/8" tricone carb. bit to 10 feet.
2) Advanced 2-15/16" tricone carb. bit from 10.0 feet to 26.5 feet.
3) Used creek water and bentonite as drilling fluid.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/6/12

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B1-A	**STATION** 12+14	**OFFSET** 4 ft LT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 683.1 ft	**TOTAL DEPTH** 19.5 ft	**NORTHING** 829,405	**EASTING** 1,782,574	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
685											
										683.1 GROUND SURFACE	0.0
										682.4 Asphalt (0.7 ft)	0.7
										681.2 Concrete (1.2 ft)	1.9
680	679.6	3.5	3	7	7	14		M		**ROADWAY EMBANKMENT** Brown sandy CLAY	
675	674.6	8.5	4	1	1	2		M		676.1 **ALLUVIAL** Red-orange sandy CLAY with brown clayey SAND seams	7.0
670	669.6	13.5	2	2	15	17		W		668.1 **WEATHERED ROCK** (Green-gray Metamorphosed Granite)	15.0
665	664.6	18.5									
	663.6	19.5	100/0.3			100/0.3				663.6	19.5
			60/0			60/0				Boring Terminated with Standard Penetration Test Refusal at Elevation 663.6 ft on Crystalline Rock (Metamorphosed Granite)	

1) Advanced 3-1/4" HSA to 19.5 feet.
2) Hard drilling at 15 feet.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/6/12

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B1-B	**STATION** 12+18	**OFFSET** 13 ft RT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 683.0 ft	**TOTAL DEPTH** 41.1 ft	**NORTHING** 829,388	**EASTING** 1,782,568	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/08/12	**COMP. DATE** 06/08/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
685										683.0 GROUND SURFACE 0.0
	679.5	3.5	WOH	2	4	6		M		**ROADWAY EMBANKMENT** Brown, sandy CLAY
680										
	674.5	8.5	WOH	WOH	2	2		M		
675										671.0 12.0
	669.5	13.5	3	6	4	10		W		**ALLUVIAL** Gray and tan, clayey SAND, trace roots
670										667.0 16.0
	664.5	18.5								**WEATHERED ROCK** (White and green Metamorphosed Granite)
665	663.5	19.5	100/0.2			100/0.2				663.5 19.5
			60/0.1			60/0.1				**CRYSTALLINE ROCK** Gray and white with green Metamorphosed Granite
660										
655										
650										
645										641.9 41.1
										Boring Terminated at Elevation 641.9 ft in Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-7/8" tricone carb. bit to 19.5 feet.
2) Advanced NW casing 10 19.5 feet.
3) Advanced NQ2 core barrel from 19.5 feet to 41.1 feet.
4) Used creek water and bentonite as drilling fluid.

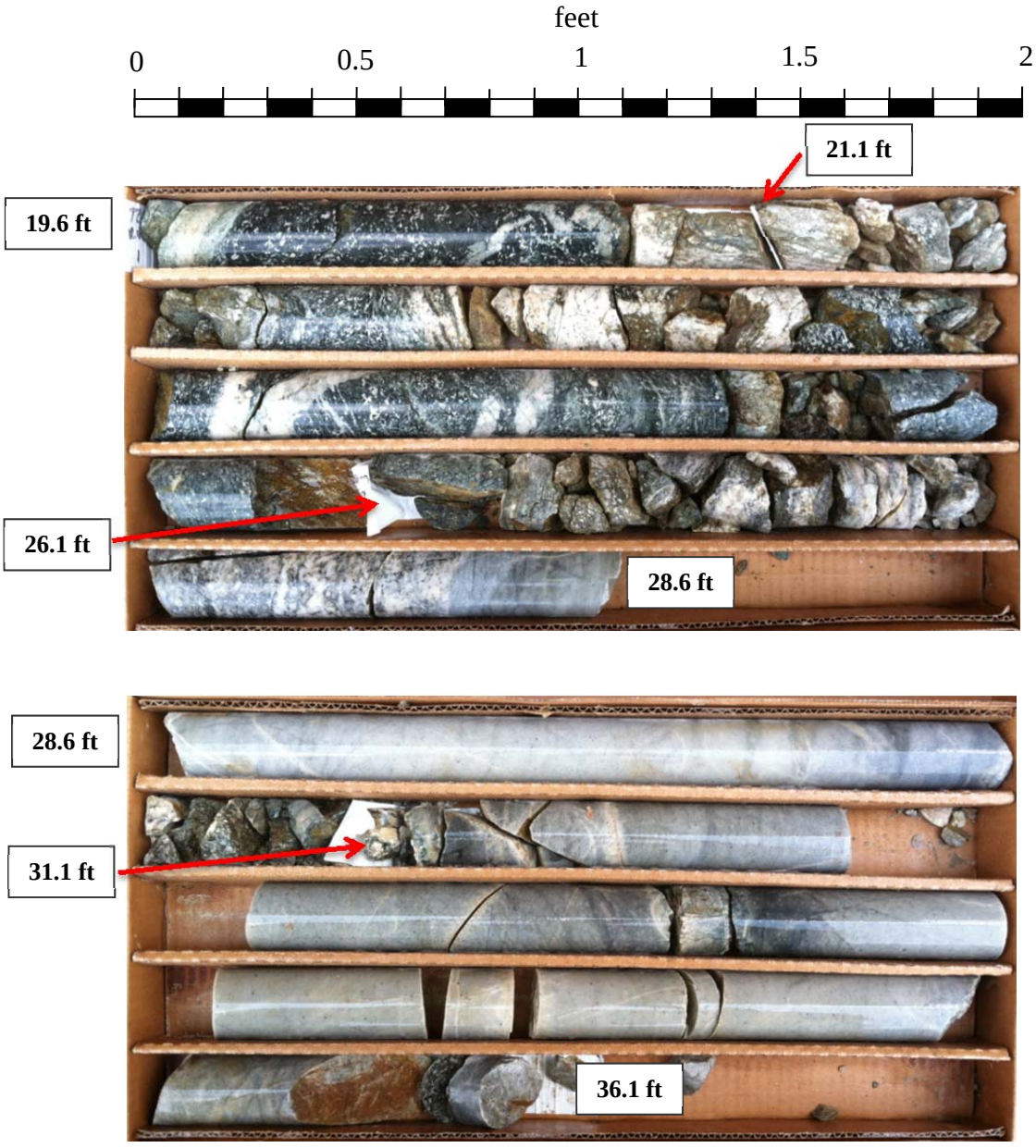
NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B1-B	**STATION** 12+18	**OFFSET** 13 ft RT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 683.0 ft	**TOTAL DEPTH** 41.1 ft	**NORTHING** 829,388	**EASTING** 1,782,568	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/08/12	**COMP. DATE** 06/08/12	**SURFACE WATER DEPTH** N/A	
CORE SIZE NQ2	**TOTAL RUN** 21.5 ft			

ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS
663.4											Begin Coring @ 19.6 ft
	663.4	19.6	1.5	5:01/1.0	(1.5)	(0.6)		(20.4)	(10.4)		**CRYSTALLINE ROCK**
	661.9	21.1		2:34/0.5	100%	42%		95%	48%		Gray and white with green, fresh to moderately severe weathering, medium hard to hard, METAMORPHOSED GRANITE, with moderately close to very close fracture spacing.
660			5.0	4:58/1.0	(4.8)	(1.3)					
				4:37/1.0							
				4:17/1.0	96%	26%					
				6:26/1.0							
	656.9	26.1		6:24/1.0							
655			5.0	5:06/1.0	(4.8)	(2.3)					
				3:40/1.0							
				5:31/1.0	96%	46%					
				6:02/1.0							
	651.9	31.1		7:52/1.0							
650			5.0	4:50/1.0	(4.8)	(2.9)					
				4:11/1.0							
				4:42/1.0	96%	58%					
				4:04/1.0							
	646.9	36.1		4:39/1.0							
645			5.0	5:21/1.0	(4.5)	(3.3)					
				3:49/1.0							
				3:05/1.0	90%	66%					
				5:02/1.0							
	641.9	41.1		3:38/1.0							641.9 41.1
											Boring Terminated at Elevation 641.9 ft in Crystalline Rock (Metamorphosed Granite)
											1) Advanced 3-7/8" tricone carb. bit to 19.5 feet.
											2) Advanced NW casing 10 19.5 feet.
											3) Advanced NQ2 core barrel from 19.5 feet to 41.1 feet.
											4) Used creek water and bentonite as drilling fluid.

North Carolina Department of Transportation
Geotechnical Unit
Rock Core Photo

T.I.P. No..: 17BP.7.R.37	*Bridge No.*: 400238	*County*: Guilford	*Boring Location:* **B1-B**
Site Description: Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			
Driller: W. Duggins	*Core Size*: NQ2	*Drill Machine:* Diedrich D-50	
Geologist / Engineer: T. Bartlett	*Total Run Length:* 21.5 feet	*Date:* 6/08/2012	



Notes:
1) Used NQ2 core barrel with wire line

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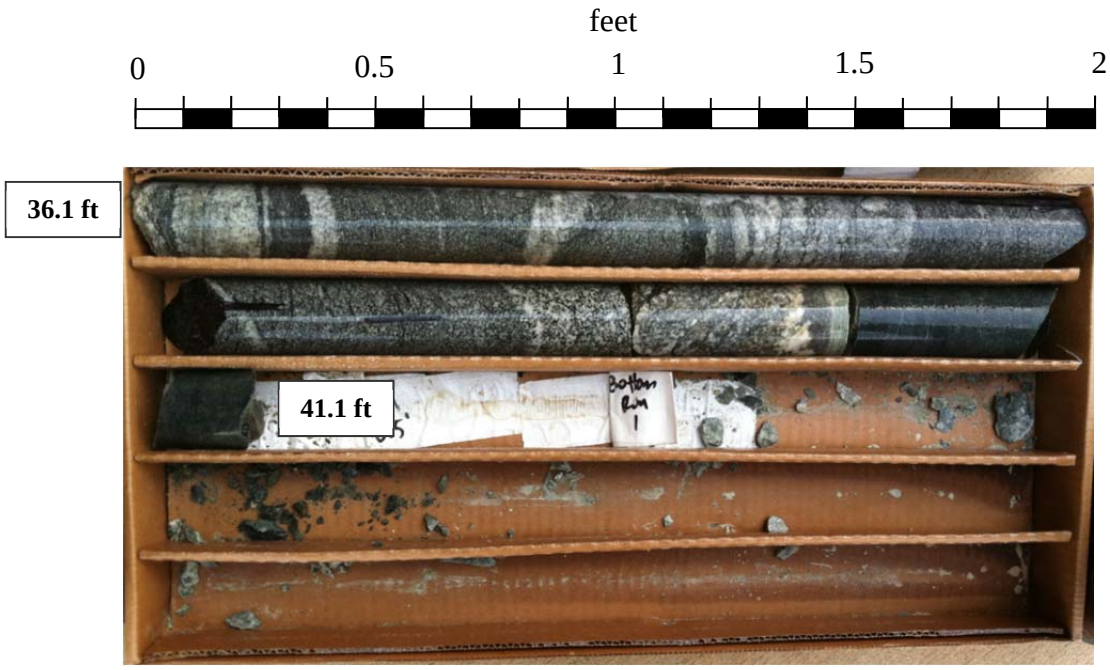
North Carolina Department of Transportation
Geotechnical Unit
Rock Core Photo

T.I.P. No..: 17BP.7.R.37	*Bridge No.*: 400238	*County*: Guilford	*Boring Location:* **B1-B**
Site Description: Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			
Driller: W. Duggins	*Core Size*: NQ2	*Drill Machine:* Diedrich D-50	
Geologist / Engineer: T. Bartlett	*Total Run Length:* 21.5 feet	*Date:* 6/08/2012	



Notes:
1) Used NQ2 core barrel with wire line

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NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B2-A	**STATION** 12+88	**OFFSET** 4 ft LT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 684.5 ft	**TOTAL DEPTH** 41.0 ft	**NORTHING** 829,366	**EASTING** 1,782,637	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
685										684.5 GROUND SURFACE 0.0
										684.0 Asphalt (0.5 ft) 0.5
										683.4 Concrete (0.6 ft) 1.1
	681.0	3.5								**ROADWAY EMBANKMENT**
680			2	1	2	3		M		Tan, sandy CLAY
	676.0	8.5								676.0 8.5
675			1	1	WOH	1		M		Yellowish-tan and brown sandy CLAY with gravel
	671.0	13.5								672.5 12.0
670			WOH	WOH	WOH	0		W		**ALLUVIAL** Light gray clayey SAND with gravel
	666.0	18.5								666.0 18.5
665			60/0			60/0				**CRYSTALLINE ROCK** Metamorphosed Granite
660										
655										
650										
645										643.5 41.0
										Boring Terminated at Elevation 643.5 ft in Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-7/8" tricone carb. bit to 18.5 feet.
2) Advanced NW casing to 18.5 feet.
3) Advanced NQ2 core barrel from 18.5 feet to 41.0 feet.
4) Used creek water and bentonite as drilling fluid.

NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

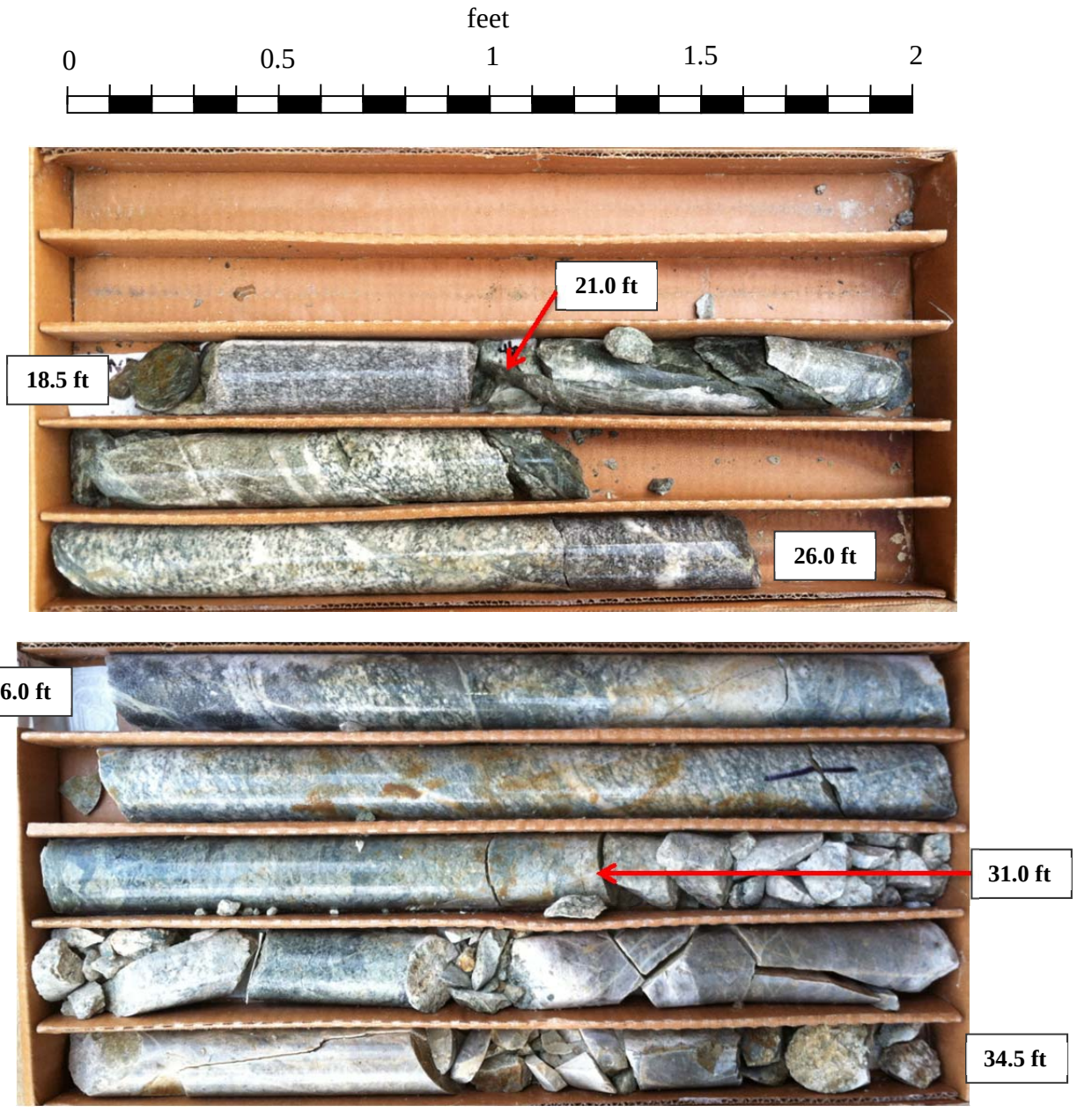
WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B2-A	**STATION** 12+88	**OFFSET** 4 ft LT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 684.5 ft	**TOTAL DEPTH** 41.0 ft	**NORTHING** 829,366	**EASTING** 1,782,637	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A	
CORE SIZE NQ2	**TOTAL RUN** 22.5 ft			

ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS
665.96											Begin Coring @ 18.5 ft
665	666.0	18.5	2.5	3:37/1.0 1:15/1.0 0:48/0.5	(0.8) 32%	(0.5) 20%		(18.3) 81%	(6.8) 30%		666.0 **CRYSTALLINE ROCK** 18.5 White and gray, fresh to moderately severe weathering, hard to very soft, METAMORPHOSED GRANITE, with moderately close to very close fracture spacing
	663.5	21.0	5.0	4:02/1.0 3:52/1.0 4:12/1.0	(3.5) 70%	(1.3) 26%					
660	658.5	26.0	5.0	4:04/1.0 4:46/1.0 4:49/1.0 4:22/1.0 4:55/1.0	(5.0) 100%	(3.8) 76%					
655	653.5	31.0	5.0	3:50/1.0 3:16/1.0 2:37/1.0 3:36/1.0 4:24/1.0	(4.8) 96%	(0.0) 0%					
650	648.5	36.0	5.0	3:54/1.0 4:01/1.0 3:57/1.0 4:56/1.0 4:48/1.0	(4.2) 84%	(1.2) 24%					
645	643.5	41.0		5:33/1.0 4:55/1.0							643.5 41.0 Boring Terminated at Elevation 643.5 ft in Crystalline Rock (Metamorphosed Granite) 1) Advanced 3-7/8" tricone carb. bit to 18.5 feet. 2) Advanced NW casing to 18.5 feet. 3) Advanced NQ2 core barrel from 18.5 feet to 41.0 feet. 4) Used creek water and bentonite as drilling fluid.

NCDOT CORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/8/12

North Carolina Department of Transportation
Geotechnical Unit
Rock Core Photo

T.I.P. No..: 17BP.7.R.37	*Bridge No.*: 400238	*County*: Guilford	*Boring Location:* **B2-A**
Site Description: Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			
Driller: W. Duggins	*Core Size*: NQ2	*Drill Machine:* Diedrich D-50	
Geologist / Engineer: T. Bartlett	*Total Run Length:* 22.5 feet	*Date:* 6/11/2012	



Notes:
1) Used NQ2 core barrel with wire line

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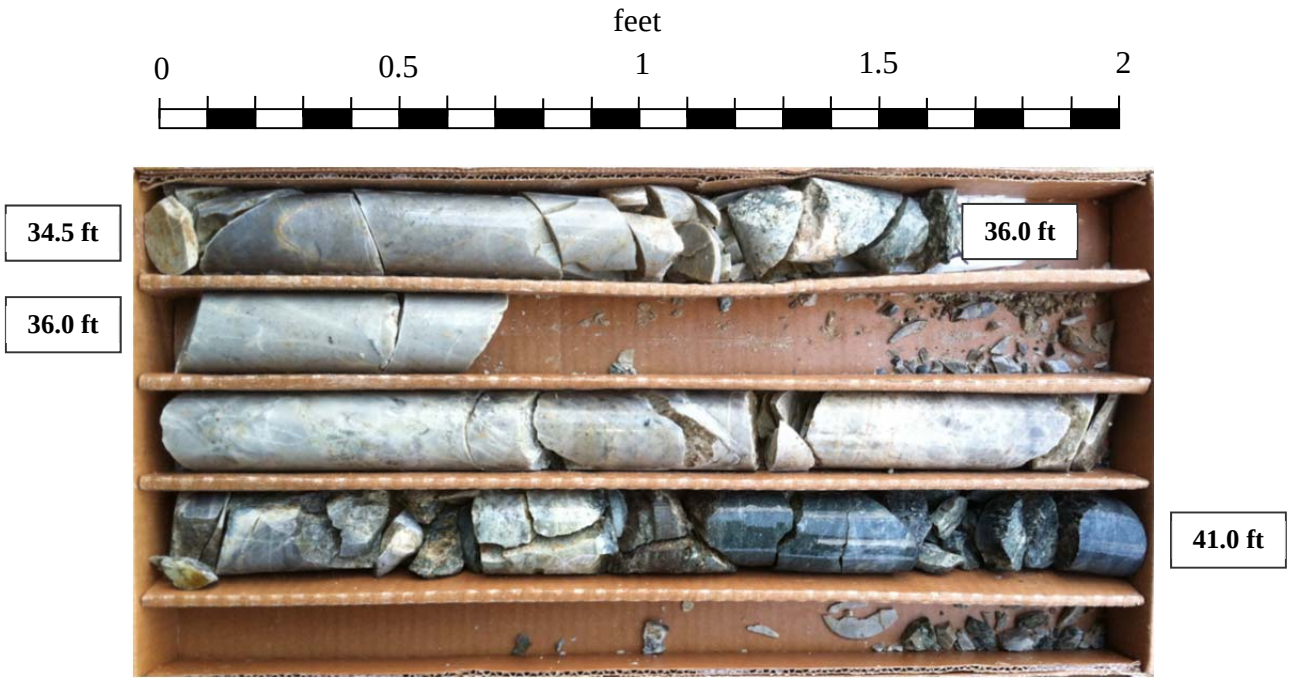
North Carolina Department of Transportation
Geotechnical Unit
Rock Core Photo

T.I.P. No.: 17BP.7.R.37	*Bridge No.*: 400238	*County*: Guilford	*Boring Location:* **B2-A**
Site Description: Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			
Driller: W. Duggins	*Core Size*: NQ2	*Drill Machine:* Diedrich D-50	
Geologist / Engineer: T. Bartlett	*Total Run Length:* 22.5 feet	*Date:* 6/11/2012	



Notes:
1) Used NQ2 core barrel with wire line

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NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B2-B	**STATION** 12+86	**OFFSET** 9 ft RT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 684.4 ft	**TOTAL DEPTH** 22.2 ft	**NORTHING** 829,356	**EASTING** 1,782,628	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/07/12	**COMP. DATE** 06/07/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
685											
										684.4 ROADWAY SURFACE	0.0
										683.4 Asphalt (1.0 ft)	1.0
										682.8 Concrete (0.6 ft)	1.6
680	680.9	3.5	1	1	2	3		M		**ROADWAY EMBANKMENT** Tan, sandy CLAY	
										677.4	7.0
675	675.9	8.5	1	1	WOH	1		M		Tan, brown and orange, sandy CLAY	
										672.4	12.0
670	670.9	13.5	WOH	WOH	WOH	0				No sample recovery	
					WOH					666.4	18.0
665	665.9	18.5	16	18	18	36				**RESIDUAL** Greenish-gray and White SAND with gravel	
	662.2	22.2	60/0			60/0				662.2	22.2
										Boring Terminated with Standard Penetration Test Refusal at Elevation 662.2 ft on Crystalline Rock (Metamorphosed Granite)	
										1) Advanced 2-15/16" tricone carb. bit to 22.2 feet. 2) Used creek water and bentonite as drilling fluid.	

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. EB2-A	**STATION** 12+99	**OFFSET** 5 ft LT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 684.8 ft	**TOTAL DEPTH** 20.0 ft	**NORTHING** 829,361	**EASTING** 1,782,646	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
685											
										684.8 GROUND SURFACE	0.0
										684.3 Asphalt (0.5 ft)	0.5
										683.5 Concrete (0.8 ft)	1.3
	681.3	3.5								681.8 **ROADWAY EMBANKMENT**	3.0
680			2	2	2	4		M		Brown silty SAND	
										Tan and green, sandy SILT	
	676.3	8.5								677.8	7.0
675			2	1	3	4		M		Tan-yellow, sandy CLAY	
										672.8	12.0
	671.3	13.5								**ALLUVIAL**	
670			WOH	WOH	WOH	0 WOH		W		Gray CLAY with trace roots	
	666.3	18.5								665.8	19.0
665	664.8	20.0	15	100/0.4		100/0.9				664.8 **WEATHERED ROCK**	20.0
			60/0			60/0				(Gray Metamorphosed Granite)	

Boring Terminated with Standard Penetration Test Refusal at Elevation 664.8 ft on Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-1/4" HSA to 20.0 feet.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/6/12

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. EB2-B	**STATION** 13+01	**OFFSET** 18 ft RT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 684.6 ft	**TOTAL DEPTH** 21.9 ft	**NORTHING** 829,341	**EASTING** 1,782,637	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/07/12	**COMP. DATE** 06/07/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
685										ELEV. (ft) 684.6 GROUND SURFACE DEPTH (ft) 0.0
	681.1	3.5	2	1	1	2		M		**ROADWAY EMBANKMENT** Orange and brown, sandy CLAY
680										
	676.1	8.5	WOH	WOH	WOH	0		M		
675					WOH					672.6 12.0
	671.1	13.5	WOH	WOH	WOH	0		M		**ALLUVIAL** Gray, sandy CLAY
670					WOH					667.6 17.0
	666.1	18.5	16	8	17	25		W		**RESIDUAL** Green and brown, sandy SILT
665										
	662.7	21.9	60/0			60/0				662.7 21.9

Boring Terminated with Standard Penetration Test Refusal at Elevation 662.7 ft on Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-7/8" tricone carb. bit to 21.9 feet.
2) Used creek water and bentonite as drilling fluid.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/6/12

FOUNDATION RECOMMENDATIONS

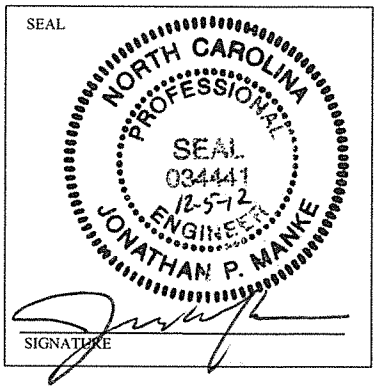
PROJECT 17BP.7.R.37 DESCRIPTION

T.I.P. NO. 17BP.7.R.37 Bridge #238 on State Route 1005 (Alamance Church

COUNTY Guilford Rd) over Little Alamance Creek

STATION ~15+47.50 -L-

	INITIALS	DATE
DESIGN	JPM	11/8/2012
CHECKED	DJC	11/8/2012
FINAL	JPM	12/5/2012



	STATION	FOUNDATION TYPE	FACTORED RESISTANCE	MISCELLANEOUS DETAILS
END BENT NO. 1	11+98.00 –L- (Old) 14+90.00 -L- (New)	Cap on 12 x 53 steel piles	85 tons/pile	Bottom of Cap Elevation = 675.48 feet +/- Estimated Average Pile Length = 15 feet Number of Piles/Cap = 6
BENT NO. 1	12+23.00 –L- (Old) 15+15.00 -L- (New)	36-inch Drilled Pier	365 tons/pier	Bottom of Cap Elevation = 676.41 feet +/- Point of Fixity Elevation* = 660.5 feet +/- Tip No Higher Than Elevation = 659.5 feet +/-, **left,** (4 feet into rock), 659 feet +/-, **right**, (4.5 feet into rock) Number of Piers/Cap = 4
BENT NO. 2	12+88.00 –L- (Old) 15+80.00 -L- (New)	36-inch Drilled Pier	365 tons/pier	Bottom of Cap Elevation = 677.43 feet +/- Point of Fixity Elevation* = 662.5 feet +/-, **left**, 658.5 feet +/-,**right** Tip No Higher Than Elevation = 661 feet +/-, **left**, (5 feet into rock), 657 feet +/-, **right,** (5 feet into rock) Number of Piers/Cap = 4
END BENT NO. 2	13+13.00 –L- (Old) 16+05.00 -L- (New)	Cap on 12 x 53 steel piles	85 tons/pile	Bottom of Cap Elevation = 677.76 feet +/- Estimated Average Pile Length = 20 feet Number of Piles/Cap = 6

*The estimated point of fixity was determined using the L-Pile program. A 30-inch diameter unyielding column supported on a 36-inch diameter unyielding shaft was used in our analysis. The structural integrity of the column and shaft was not verified in our analysis and should be verified by the structural engineer.

COMMENTS & NOTES (See Following Page)

FOUNDATION RECOMMENDATION NOTE ON PLANS AND COMMENTS

W.B.S. No.: 17BP.7.R.37 BRIDGE NO: 400238 COUNTY: Guilford
STATION: ~15+47.50 -L-
DESCRIPTION: Bridge #238 on SR 1005 (Alamance Church Rd) over Little Alamance Creek

Note on Plans:

1. FOR PILES, SEE SECTION 450 OF THE STANDARD SPECIFICATION.

2. PILES AT END BENT NOS. 1 AND 2 ARE DESIGNED FOR A FACTORED RESISTANCE OF 85 TONS PER PILE.

3. DRIVE PILES AT BENT NOS. 1 AND 2 TO A REQUIRED DRIVING RESISTANCE OF 145 TONS PER PILE.

4. STEEL H-PILE POINTS ARE REQUIRED FOR STEEL H-PILES AT END BENT NOS. 1 AND 2. FOR STEEL PILE POINTS, SEE SECTION 450 OF THE STANDARD SPECIFICATIONS.

5. FOR DRILLED PIERS, SEE SECTION 411 OF THE STANDARD SPECIFICATIONS.

6. DRILLED PIERS AT BENT NO. 1 ARE DESIGNED FOR A FACTORED RESISTANCE OF 365 TONS PER PIER. CHECK FIELD CONDITIONS FOR THE REQUIRED TIP RESISTANCE OF 120 TSF.

7. INSTALL DRILLED PIERS AT BENT NO. 1 TO A TIP ELEVATION NO HIGHER THAN 659.5 FT, LEFT, AND 659 FT, RIGHT, AND WITH THE REQUIRED TIP RESISTANCE AND PENETRATION INTO ROCK OF AT LEAST 4 FT, LEFT AND 4.5 FT, RIGHT AS DEFINED BY ARTICLE 411-1 OF THE STANDARD SPECIFICATIONS.

8. DRILLED PIERS AT BENT NO. 2 ARE DESIGNED FOR A FACTORED RESISTANCE OF 365 TONS PER PIER. CHECK FIELD CONDITIONS FOR THE REQUIRED TIP RESISTANCE OF 120 TSF.

9. INSTALL DRILLED PIERS AT BENT NO. 2 TO A TIP ELEVATION NO HIGHER THAN 661 FT, LEFT, AND 657 FEET, RIGHT, AND WITH THE REQUIRED TIP RESISTANCE AND PENETRATION INTO ROCK OF AT LEAST 5 FT, AS DEFINED BY ARTICLE 411-1 OF THE STANDARD SPECIFICATIONS.

10. CSL TUBES ARE REQUIRED AND CSL TESTING MAY BE REQUIRED FOR DRILLED PIERS. THE ENGINEER WILL DETERMINE THE NEED FOR CSL TESTING. FOR CSL TESTING, SEE SECTION 411 OF THE STANDARD SPECIFICATIONS.

11. THE SCOUR CRITICAL ELEVATION FOR BENT NOS. 1 AND 2 IS ELEVATION 667 FT. SCOUR CRITICAL ELEVATIONS ARE USED TO MONITOR POSSIBLE SCOUR PROBLEMS DURING THE LIFE OF THE STRUCTURE.

Comments:

1. USE 1.5 : 1 (H:V) END BENT SLOPES WITH CLASS II RIP-RAP SLOPE PROTECTION.

FOUNDATION RECOMMENDATION NOTE ON PLANS AND COMMENTS

W.B.S. No.: 17BP.7.R.37 BRIDGE NO: 400238 COUNTY: Guilford
STATION: ~15+47.50 -L-
DESCRIPTION: Bridge #238 on SR 1005 (Alamance Church Rd) over Little Alamance Creek

2. THE AVERAGE FACTORED AXIAL LOAD AT END BENT NOS. 1 AND 2 IS 85 TONS PER PILE.

3. THE MAXIMUM FACTORED AXIAL LOAD AT BENT NOS. 1 AND 2 IS 363 TONS PER PIER.

4. PLEASE ADVISE OUR OFFICE IF THE FACTORED RESISTANCE IS LESS THAN THE MAXIMUM FACTORED AXIAL LOAD.

5. THE DESIGN SCOUR ELEVATION AT BENT NOS. 1 AND 2 IS 670 FT.

6. USE SUB-REGIONAL BRIDGE APPROACH FILLS AT BOTH END BENTS.

DRILLED PIER PAY ITEMS

(For LRFD Projects - Revised 8/15/12)

WBS ELEMENT 17BP.7.R.37 DATE 11/8/2012

TIP NO. 17BP.7.R.37 DESIGNED BY J. Manke

COUNTY GUILFORD CHECKED BY D. Corley

STATION ~15+47.50 -L-

DESCRIPTION Bridge No. 238 on SR 1005 (Alamance Church Road) over Little Alamance Creek

NUMBER OF BENTS WITH DRILLED PIERS 2

NUMBER OF DRILLED PIERS PER BENT 4

NUMBER OF END BENTS WITH DRILLED PIERS

NUMBER OF DRILLED PIERS PER END BENT

	DRILLED PIER PAY ITEM QUANTITIES				
Bent # or End Bent #	**Permanent Steel Casing For 36-inch Dia. Drilled Pier (yes/no/maybe)**	**36-inch Dia. Drilled Piers Not In Soil (per linear ft)**	**SID Inspections (per each)**	**SPT Testing (per each)**	**CSL Testing (per each)**
Bent No. 1	no	25			1
Bent No. 2	no	20			1
TOTALS		45	0	0	2

Notes:

Blanks or "no" represent quantity of zero.

If drilled piers not in soil are required, calculate quantity of "36-inch Dia. Drilled Piers in Soil" as the difference between the total drilled pier length and the "36-inch Dia. Drilled Piers Not in Soil" from the table above. If there is none or zero quantity for drilled piers not in soil in the table above, calculate quantity of "36-inch Dia. Drilled Piers" as the total drilled pier length and do not use the "36-inch Dia. Drilled Piers in Soil" pay item.

If permanent steel casing is or may be required, calculate quantity of "Permanent Steel Casing for 36-inch Dia. Drilled Pier" as the difference between the ground line or top of drilled pier elevation, whichever is higher, and the elevation the permanent casing can not extend below from the foundation recommendations.

If "SID Inspections", "SPT Testing" or "CSL Testing" may be required, show quantities of these pay items on the plans as totals only. If "SID Inspections", "SPT Testing" or "CSL Testing" is required, show quantities of these pay items on the plans for each bent or end bent.

The number of CSL tubes required per drilled pier is equal to one tube per foot of design pier diameter with at least 4 tubes per pier. Calculate the length of each CSL tube as the total drilled pier length plus 1.5 ft.

PILE PAY ITEMS

(Revised 8/15/12)

WBS ELEMENT 17BP.7.R.37 DATE 11/8/2012

TIP NO. 17BP.7.R.37 DESIGNED BY J. Manke

COUNTY Guilford CHECKED BY D. Corley

STATION ~15+47.50 -L-

DESCRIPTION Bridge No. 238 on SR 1005 (Alamance Church Road) over Little Alamance Creek

NUMBER OF BENTS WITH PILES

NUMBER OF PILES PER BENT

NUMBER OF END BENTS WITH PILES

NUMBER OF PILES PER END BENT

Only required for "Predrilling for Piles" & "Pile Excavation" pay items

	PILE PAY ITEM QUANTITIES						
					Pile Excavation (per linear ft)		
Bent # or End Bent #	Steel Pile Points (yes/no)	Pipe Pile Plates (yes/no/maybe)	Predrilling For Piles (per linear ft)	Pile Redrives (per each)	In Soil	Not In Soil	PDA Testing (per each)
End Bent 2	yes	no	no	no	no	no	
End Bent 1	yes	no	no	no	no	no	
TOTALS			0	0	0	0	

Notes:

Blanks or "no" represent quantity of zero.

If steel pile points are required, calculate quantity of "Steel Pile Points" as equal to the number of steel piles.

If pipe pile plates are or may be required, calculate the quantity of "Pipe Pile Plates" as equal to the number of pipe piles.

Show quantity of "PDA Testing" on the plans as total only.

If quantity of "PDA Testing" is 3 or less, reference "Pile Driving Criteria" provision in PDA notes on plans and include "Pile Driving Criteria" provision in the contract.

CALCULATIONS

BRIDGE 400238 – GUILFORD COUNTY

DESIGN CALCULATIONS AND DISCUSSION

APPENDIX A – END BENT ANALYSES

APPENDIX A-1 –END BENT 1
APPENDIX A-2 –END BENT 2

APPENDIX B – INTERIOR BENT ANALYSES

APPENDIX B-1 – BENT 1, BORING B1-A
APPENDIX B-2 – BENT 1, BORING B1-B
APPENDIX B-3 – BENT 2, BORING B2-A
APPENDIX B-4 – BENT 2, BORING B2-B
APPENDIX B-5 – PIER PAY ITEMS

BRIDGE 400238 DESIGN COMMENTS AND CALCULATIONS

The following table summarizes the loads provided for the interior bents with 4, 3-foot shafts at each bent:

Table 1. Provided Controlling Column Factored Loads for 4 Shafts

	Case 1	Case 2	Case 3
Axial	-725 k	-581 k	-368 k
Shear	-12 k	-15 k	-12 k
Moment	-255 kft	-230 kft	-141 kft

L-PILE CALCULATIONS:

The provided loads are based on being applied at the "bottom of the cap" elevation. The bottom of cap elevation has been provided by Kimley Horn and Associates as 676.41 for Bent 1 and 677.43 feet for Bent 2. The top of shaft elevation for the Bents were also provided by KHA as 672.8 feet. The 100 year design scour elevation was provided as 668 feet. As such, any soil above this elevation is not considered to provide lateral resistance. In some instances, very soft and loose soil was present below the design scour elevation and was also ignored for providing lateral resistance.

We understand that NCDOT prefers to review only two loading cases, the maximum shear case (Case 2) with free head condition and the maximum transverse shear case (Case 3) with fixed head condition.

In order to run the fixed-head case, the moment needs to be converted to a shear at the top of the column and then summed with the applied shear. The moment must be divided by the unsupported length of the shaft/column (the unsupported length is from the bottom of the cap to the point of fixity). The following table summarizes the elevations utilized in determining the unsupported length to be used in converting the moment to a shear for the fixed-head condition. The table also provides the "Column Length" which is used in the L-pile analysis as the top section of the shaft.

Table 2. Calculations for the Unsupported Length and Column Length

Boring	(A) Bottom of Cap Elevation	(B) Top of Shaft Elevation	(C) Column Length = (A) –(B)	(D) Est. Point of Fixity	(E) Unsupported Length (A)-(D)
B1-A	676.41	672.8	3.61	661	15.5
B1-**B**	676.41	672.8	3.61	661	15.5
B2-A	677.43	672.8	4.63	663	14.5
B2-B	677.43	672.8	4.63	659	18.5

Table 3. Calculations for Shear for Case 3 with fixed-head.

Boring	Shear (k)	Moment (k-ft)	Unsupported Length (ft)	Calculated Shear from Moment (k)	Net Shear (k)
B1-A	12	141	15.5	9	21
B1-**B**	12	141	15.5	9	21
B2-A	12	141	14.5	10	22
B2-B	12	141	18.5	8	20

Based on the aforementioned discussion and calculations, the following 2 cases with the units adjusted for L-Pile input were analyzed for each boring location.

Table 4. Load Cases for L-Pile – Free Head Condition

	Case 2	Case 3
Axial	581,000 lb	368,000 lb
Shear	15,000 lb	See Table 3.
Moment / Slope	2,760,000 lb-in	0 radians

A summary of deflection, maximum moment, and maximum shear is on the last page of each L-Pile output.

Table 5. Point of Fixity from L-Pile Analyses for Case 2 only.

Boring	Depth to Bottom of Shaft (in-ft)	Depth to Point of Fixity (in)*	(a) Depth to Point of Fixity (ft)	(b) Top of Column Elevation	(c) Point of Fixity Elevation (ft)
B1-A	204 - 17	192	16	676.41	~660.5
B1-**B**	210 – 17.5	191	16	676.41	~660.5
B2-A	198 – 16.5	178	15	677.43	~662.5
B2-B	246 – 20.5	226	19	677.43	~658.5

*Point of Fixity is taken as the point of maximum negative deflection.

AXIAL CALCULATIONS:
The maximum factored axial load provided is 725 kips.

Bents 1 and 2
- Based on the L-Pile analyses, each pier will be required to be advanced approximately 4 to 5 feet into the underlying bedrock and a combination of side resistance and tip resistance will be used. The rock cores indicate the rock type is Metamorphosed Granite. Based on the NCDOT Rock Database, the typical unconfined compressive strength for these rock types in Guilford County range from 10,000 to 20,000 psi; however, the lowest unconfined test results was observed to be 8,000 psi (1,152 ksf). As such, an unconfined compressive strength of 1,152 ksf was used as part of the design. The attached spreadsheets indicate that a total factored resistance of greater than 2,000 kips can be expected for a 3-foot diameter pier (with a 2.8333 foot rock socket) advanced to a depth of 4 to 5 feet into rock, which is much greater than the required 725 kips.

Critical Scour Elevations

The 100-year hydraulic scour elevation was provided at both bents to be approximately 670 feet. The 100-year hydraulic scour elevation is the design scour elevation. The critical scour elevation is considered 2 to 3 feet below the 100-year design scour elevation.

Table 6. Scour Critical Elevation

Boring	100-Year Hydraulic Scour Elevation (HSE)	100-Year Design Scour Elevation (DSE)	Scour Critical Elevation (SCE)*
B1-A	669.5	669.5	667
B1-B	669.5	669.5	667
B2-A	670	670	667
B2-B	670	670	667

*SCE is taken as approximately 2 to 3 feet below the 100-yr design scour elevation

APPENDIX A – END BENT ANALYSES

APPENDIX A-1 –END BENT 1

BORINGS EB1-A AND EB1-B WITH RELEVANT ELEVATIONS
WEAP ANALYSES FOR EB1-A AND EB1-B

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. EB1-A	**STATION** 11+98	**OFFSET** 4 ft LT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 682.9 ft	**TOTAL DEPTH** 20.0 ft	**NORTHING** 829,413	**EASTING** 1,782,560	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
685										682.9 GROUND SURFACE	0.0
										682.0 Asphalt (0.9 ft)	0.9
										681.2 Concrete (0.8 ft)	1.7
680	679.4	3.5	4	3	4	7		M		**ROADWAY EMBANKMENT** Tan-orange sandy CLAY	
675	674.4	8.5	1	3	1	4		M		675.9 Red-brown sandy CLAY	7.0
670	669.4	13.5	8	10	9	19		M		670.9 **RESIDUAL** Tan silty SAND	12.0
665	664.4	18.5	100/0.5							666.9 **WEATHERED ROCK** (Tan-brown Metamorphosed Granite)	16.0
	662.9	20.0	60/0			60/0				662.9	20.0

BOC ~ 675.48

Tip ~665

Boring Terminated with Standard Penetration Test Refusal at Elevation 662.9 ft on Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-1/4" HSA to 20.0 feet.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/8/12

GRLWEAP 2005-2-Terracon Consultants Inc - [BRIDGE~1.GWW]

File Edit View Options Tools Window Help

English | Simple Resistance Distr | Uniform Pile | Bearing Graph - prop. shaft resistance

Bridge 238- EB1A

Hammer Information

Select from following list [8/28/2009-2003]: ID: 41

ID	Name	Type	Ram Wt	Energy/Power
39	DELMAG D 14-42	OED	3.086	34.501
40	DELMAG D 19-32	OED	4.000	42.440
41	DELMAG D 19-42	OED	4.000	43.240

Hammer parameters

Efficiency	0.8			
Pressure	1520.0	psi	Fixed 100	%
Stroke	10.81	ft	Variable	of Max

Pile material

Concrete ○ Steel ● Timber ○

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	10.5 ft	Auto	Segments
Penetration	10.5 ft	Auto.	S-Length
Section Area	15.5 in^2	Auto.	S-St. Wt
Elast Modulus	30000. ksi		
Spec Weight	492.0 lb/ft^3		
Toe Area	144. in^2	0	Splices
Perimeter	4. ft	Pile Type:	
Pile Size	12. in	H Pile	

Ultimate Capacities (up to 10)

kips

1	230.0	6	330.0
2	250.0	7	350.0
3	270.0	8	370.0
4	290.0	9	390.0
5	310.0	10	410.0

Incr. 0 Action >>

Soil Parameters

Quake

Shaft 0.1 in Const

Toe 0.1 in

Damping

Shaft 0.116 s/ft Const

Toe 0.15 s/ft Smith

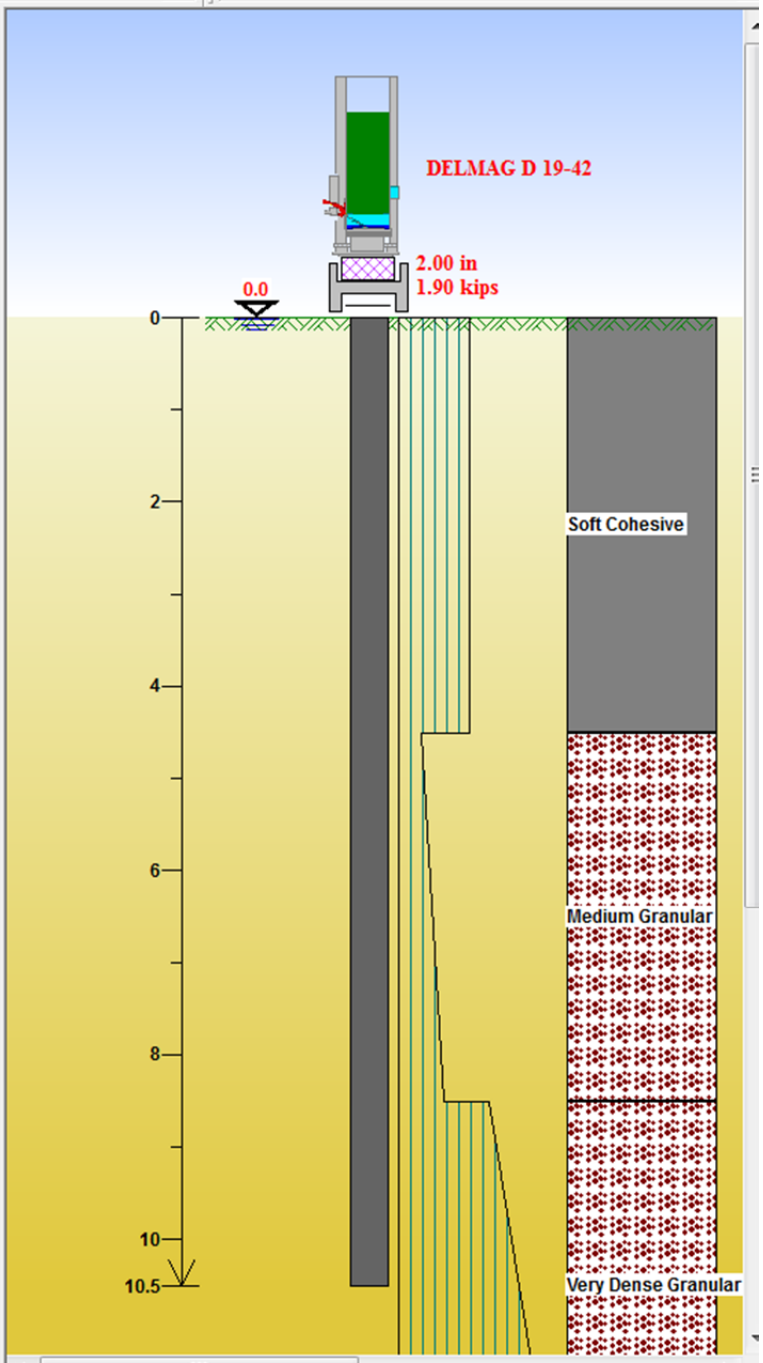
Shaft Resistance

Percentage 9 %

100%

Dist. Shape Numb 0.0

Residual Stress Analysis: No

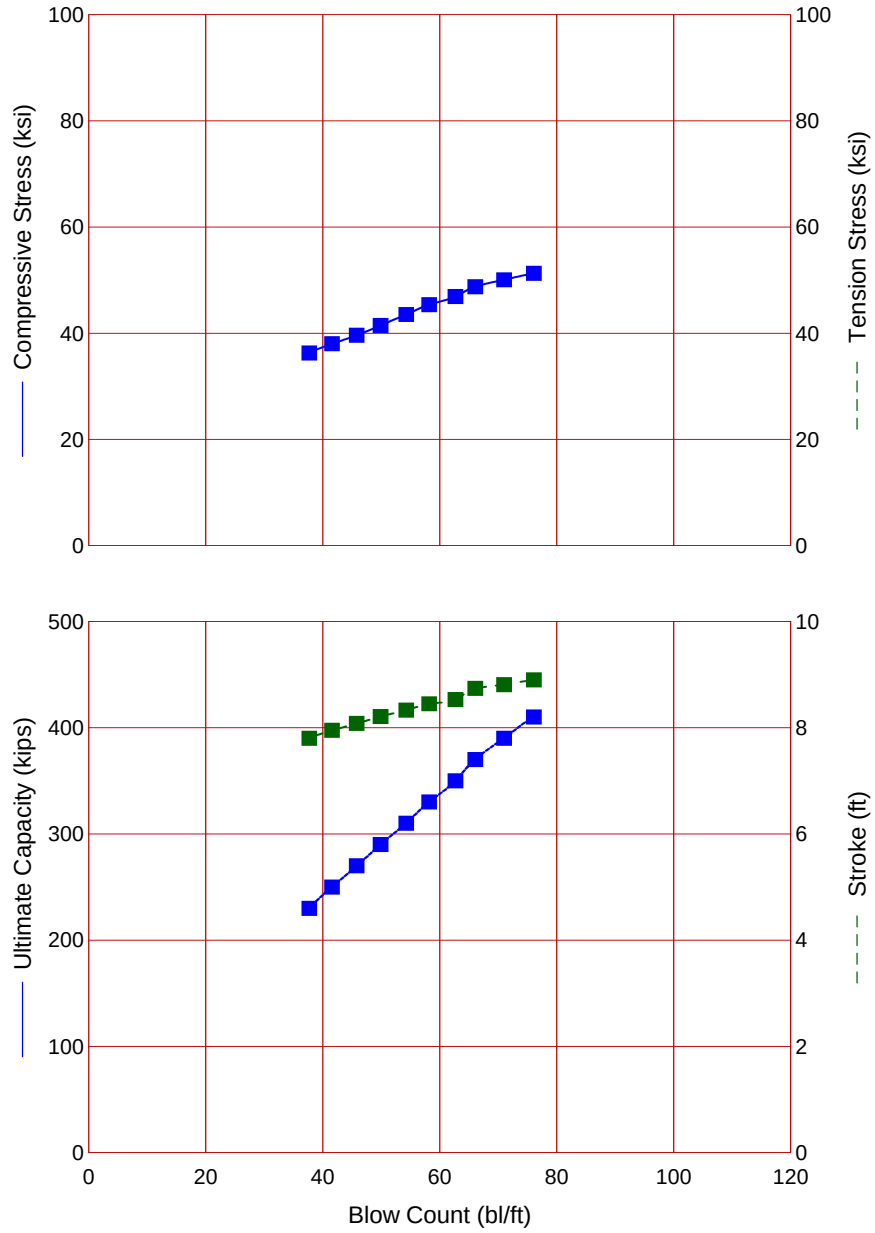


Press F1 for General Help Topics or F3 for Specific Help on Current Parameters

NUM

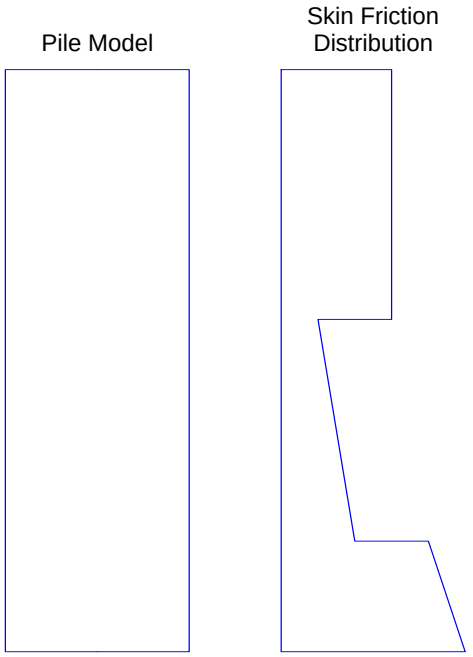
Terracon Consultants Inc
Bridge 238- EB1A

06-Nov-2012
GRLWEAP (TM) Version 2005



DELMAG D 19-42

Efficiency	0.800	
Helmet	1.90	kips
Hammer Cushion	60155	kips/in
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.116	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	10.50	ft
Pile Penetration	10.50	ft
Pile Top Area	15.50	in2



Res. Shaft = 9 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
230.0	36.28	0.00	37.7	7.80	14.70
250.0	38.01	0.00	41.6	7.95	14.62
270.0	39.62	0.00	45.8	8.08	14.50
290.0	41.47	0.00	49.9	8.21	14.48
310.0	43.51	0.00	54.3	8.33	14.52
330.0	45.37	0.00	58.2	8.45	14.60
350.0	46.91	0.00	62.7	8.53	14.53
370.0	48.76	0.00	66.1	8.74	14.80
390.0	50.05	0.00	71.0	8.81	14.73
410.0	51.27	0.00	76.1	8.90	14.70

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. EB1-B	**STATION** 11+98	**OFFSET** 12 ft RT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 682.9 ft	**TOTAL DEPTH** 26.5 ft	**NORTHING** 829,399	**EASTING** 1,782,551	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic	
DRILLER Duggins, W.T.	**START DATE** 06/07/12	**COMP. DATE** 06/07/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
685										682.9 GROUND SURFACE	0.0
										ROADWAY EMBANKMENT Red-orange, sandy CLAY	
680	679.4	3.5	WOH	WOH	WOH	0		M			
					WOH						
675	674.4	8.5	WOH	1	WOH	1		M		BOC ~ 675.48	
										670.9	12.0
670	669.4	13.5	8	19	24	43		W		Greenish-gray and white, silty SAND with gravel	
665	664.4	18.5	60/0.1			60/0.1				664.4 **WEATHERED ROCK** (Gray and white Metamorphosed Granite)	18.5
										Tip ~ 663	
660	659.4	23.5	100/0.3			100/0.3					
	656.4	26.5	60/0			60/0				656.4 Boring Terminated with Standard Penetration Test Refusal at Elevation 656.4 ft on Crystalline Rock (Metamorphosed Granite)	26.5

1) Advanced 3-7/8" tricone carb. bit to 10 feet.
2) Advanced 2-15/16" tricone carb. bit from 10.0 feet to 26.5 feet.
3) Used creek water and bentonite as drilling fluid.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/8/12

GRLWEAP 2005-2-Terracon Consultants Inc - [Bridge 238- EB1b.gww]

File Edit View Options Tools Window Help

English | Simple Resistance Distr | Uniform Pile | Bearing Graph - prop. shaft resistance

Bridge 238- EB1B

Hammer Information

Select from following list [8/28/2009-2003]: ID: 41

ID	Name	Type	Ram Wt	Energy/Power
39	DELMAG D 14-42	OED	3.086	34.501
40	DELMAG D 19-32	OED	4.000	42.440
41	DELMAG D 19-42	OED	4.000	43.240

Hammer parameters

Efficiency	0.8			
Pressure	1520.0	psi	Fixed 100	%
Stroke	10.81	ft	Variable	of Max

Pile material

Concrete (○) Steel (●) Timber (○)

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	13.	ft	Auto	Segments
Penetration	13.	ft	Auto.	S-Length
Section Area	15.5	in^2	Auto.	S-St. Wt
Elast Modulus	30000.	ksi		
Spec Weight	492.0	lb/ft^3		
Toe Area	144.	in^2	0	Splices
Perimeter	4.	ft	Pile Type:	
Pile Size	12.	in	H Pile	

Ultimate Capacities (up to 10)

kips

1	230.0	6	330.0
2	250.0	7	350.0
3	270.0	8	370.0
4	290.0	9	390.0
5	310.0	10	410.0

Incr. 0 Action >>

Soil Parameters

Quake

Shaft 0.1 in Const

Toe 0.1 in

Damping

Shaft 0.071 s/ft Const

Toe 0.15 s/ft Smith

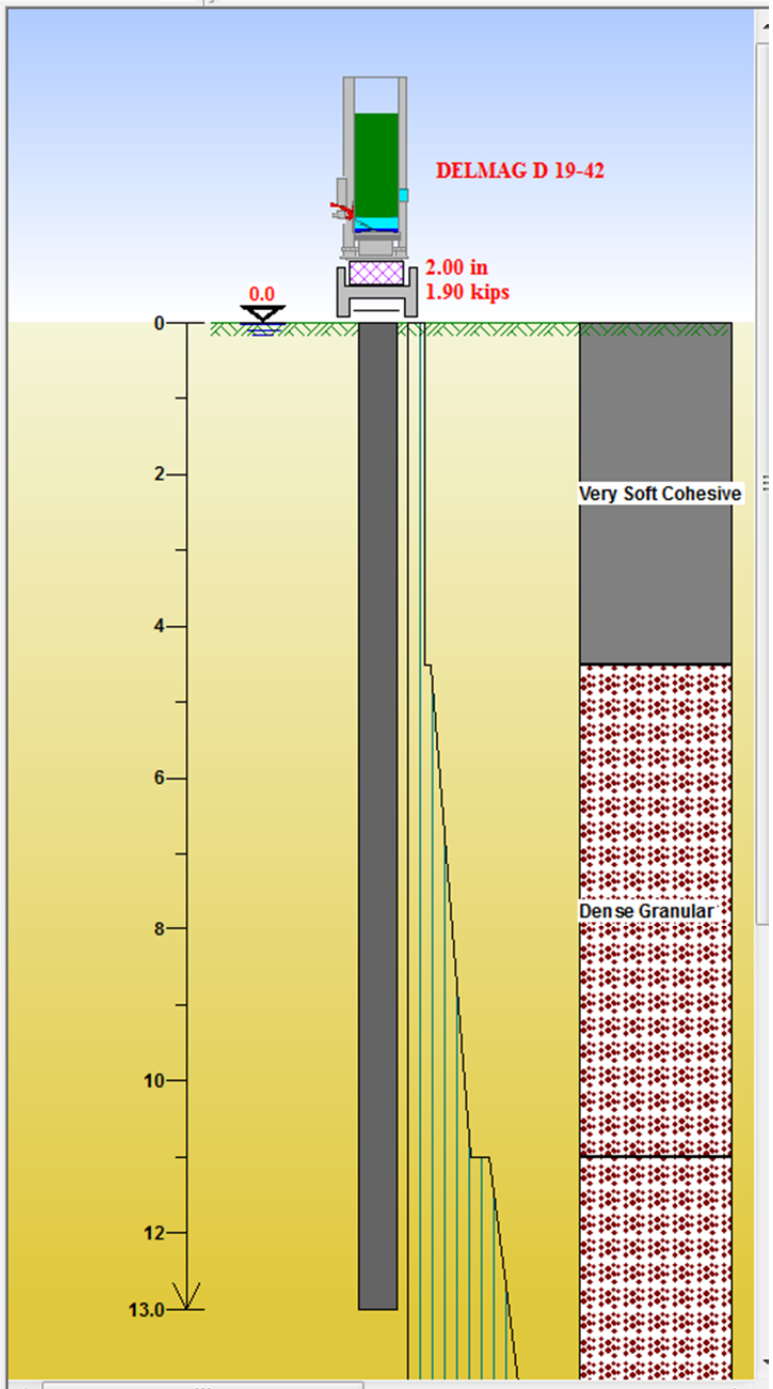
Shaft Resistance

Percentage 8 %

100%

Dist. Shape Numb 0.0

Residual Stress Analysis: No

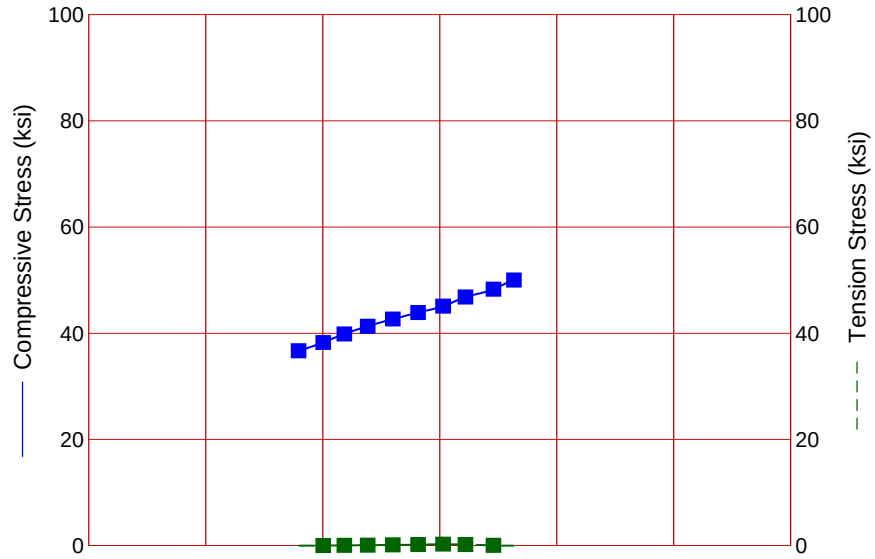


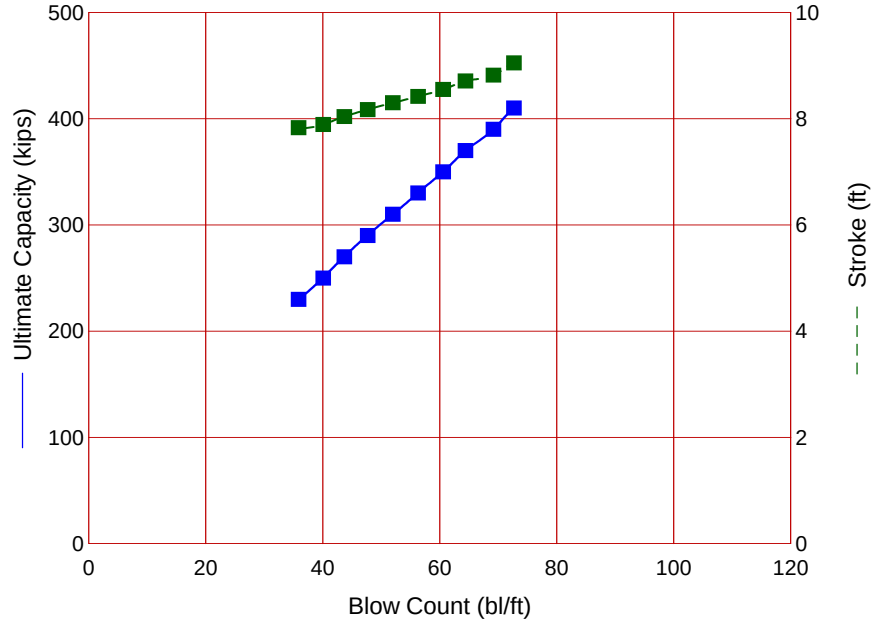
Press F1 for General Help Topics or F3 for Specific Help on Current Parameters

NUM

Terracon Consultants Inc
Bridge 238- EB1B

06-Nov-2012
GRLWEAP (TM) Version 2005



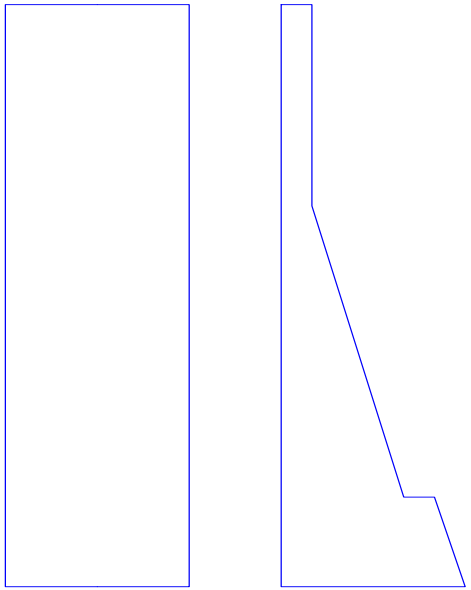


DELMAG D 19-42

Efficiency	0.800	
Helmet	1.90	kips
Hammer Cushion	60155	kips/in
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.071	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	13.00	ft
Pile Penetration	13.00	ft
Pile Top Area	15.50	in2

Pile Model

Skin Friction Distribution



Res. Shaft = 8 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
230.0	36.70	0.00	35.9	7.83	15.38
250.0	38.25	0.02	40.1	7.89	15.07
270.0	39.84	0.07	43.7	8.04	15.06
290.0	41.30	0.10	47.7	8.17	14.98
310.0	42.66	0.15	52.0	8.30	15.03
330.0	43.90	0.19	56.3	8.42	15.11
350.0	45.09	0.29	60.6	8.55	15.22
370.0	46.82	0.22	64.4	8.71	15.47
390.0	48.29	0.07	69.2	8.82	15.57
410.0	50.03	0.00	72.7	9.05	15.99

APPENDIX A-2 –END BENT 2

BORINGS EB2-A AND EB2-B WITH RELEVANT ELEVATIONS
WEAP ANALYSES FOR EB2-A AND EB2-B

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. EB2-A	**STATION** 12+99	**OFFSET** 5 ft LT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 684.8 ft	**TOTAL DEPTH** 20.0 ft	**NORTHING** 829,361	**EASTING** 1,782,646	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	ELEV. (ft)	DEPTH (ft)
685												
										GROUND SURFACE	684.8	0.0
										Asphalt (0.5 ft)	684.3	0.5
										Concrete (0.8 ft)	683.5	1.3
	681.3	3.5								**ROADWAY EMBANKMENT**	681.8	3.0
680			2	2	2	4		M		Brown silty SAND		
										Tan and green, sandy SILT		
	676.3	8.5								Tan-yellow, sandy CLAY	677.8	7.0
675			2	1	3	4		M				
	671.3	13.5								**ALLUVIAL**	672.8	12.0
670			WOH	WOH	WOH	0 WOH		W		Gray CLAY with trace roots		
	666.3	18.5										
665	664.8	20.0	15	100/0.4		100/0.9				**WEATHERED ROCK**	665.8	19.0
			60/0			60/0				(Gray Metamorphosed Granite)	664.8	20.0

BOC ~ 677.76

Tip ~ 664

Boring Terminated with Standard Penetration Test Refusal at Elevation 664.8 ft on Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-1/4" HSA to 20.0 feet.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/8/12

GRLWEAP 2005-2-Terracon Consultants Inc - [Bridge 238- EB2a.gww]

File Edit View Options Tools Window Help

English | Simple Resistance Distr | Uniform Pile | Bearing Graph - prop. shaft resistance

Bridge 238- EB2A

Hammer Information

Select from following list [8/28/2009-2003]: ID: 41

ID	Name	Type	Ram Wt	Energy/Power
39	DELMAG D 14-42	OED	3.086	34.501
40	DELMAG D 19-32	OED	4.000	42.440
41	DELMAG D 19-42	OED	4.000	43.240

Hammer parameters

Efficiency	0.8			
Pressure	1520.0	psi	Fixed 100	%
Stroke	10.81	ft	Variable	of Max

Pile material

Concrete ○ Steel ● Timber

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	14.	ft	Auto	Segments
Penetration	14.	ft	Auto.	S-Length
Section Area	15.5	in^2	Auto.	S-St. Wt
Elast Modulus	30000.	ksi		
Spec Weight	492.0	lb/ft^3		
Toe Area	144.	in^2	0	Splices
Perimeter	4.	ft	Pile Type:	
Pile Size	12.	in	H Pile	

Ultimate Capacities (up to 10)

kips

1	230.0	6	330.0
2	250.0	7	350.0
3	270.0	8	370.0
4	290.0	9	390.0
5	310.0	10	410.0

Incr. 0 Action >>

Soil Parameters

Quake

Shaft 0.1 in Const

Toe 0.1 in

Damping

Shaft 0.13 s/ft Const

Toe 0.15 s/ft Smith

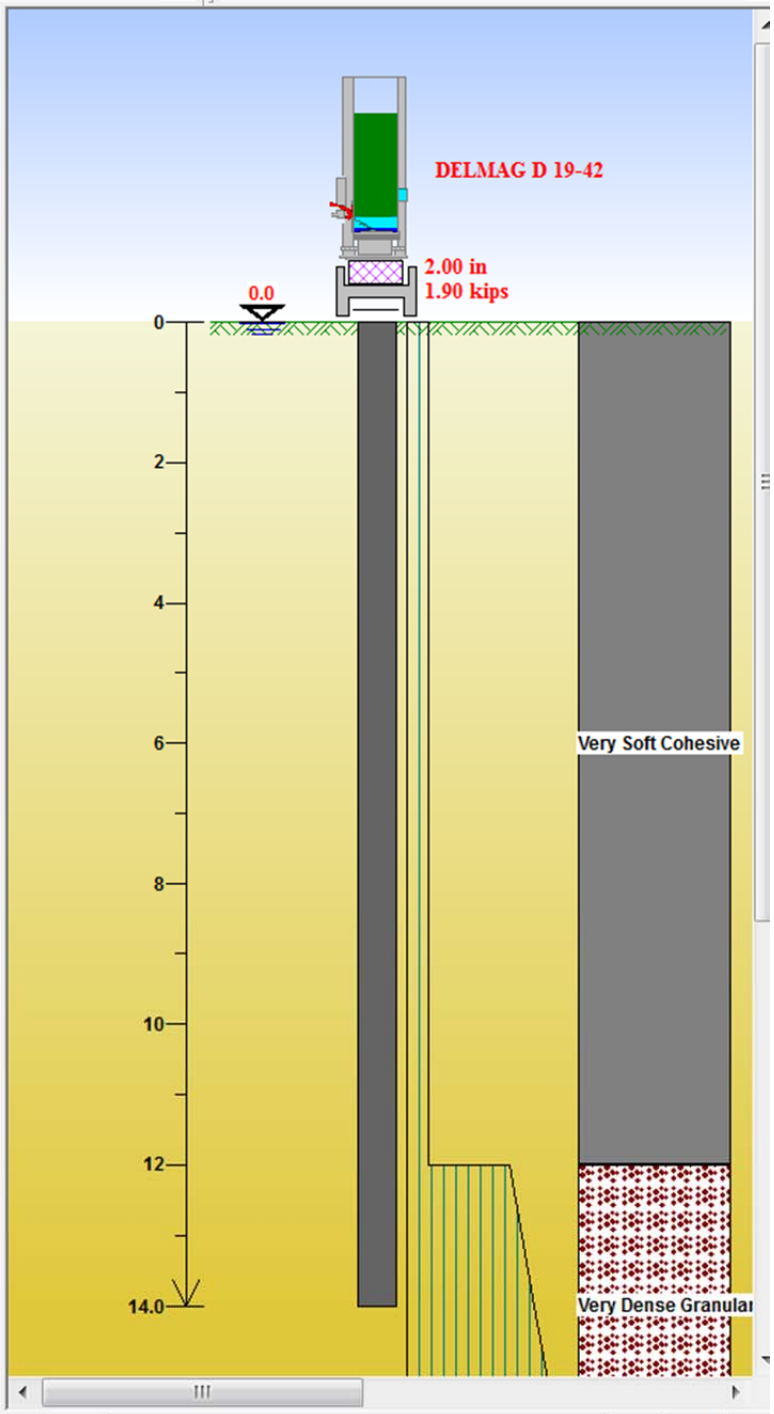
Shaft Resistance

Percentage 6 %

100%

Dist. Shape Numb 0.0

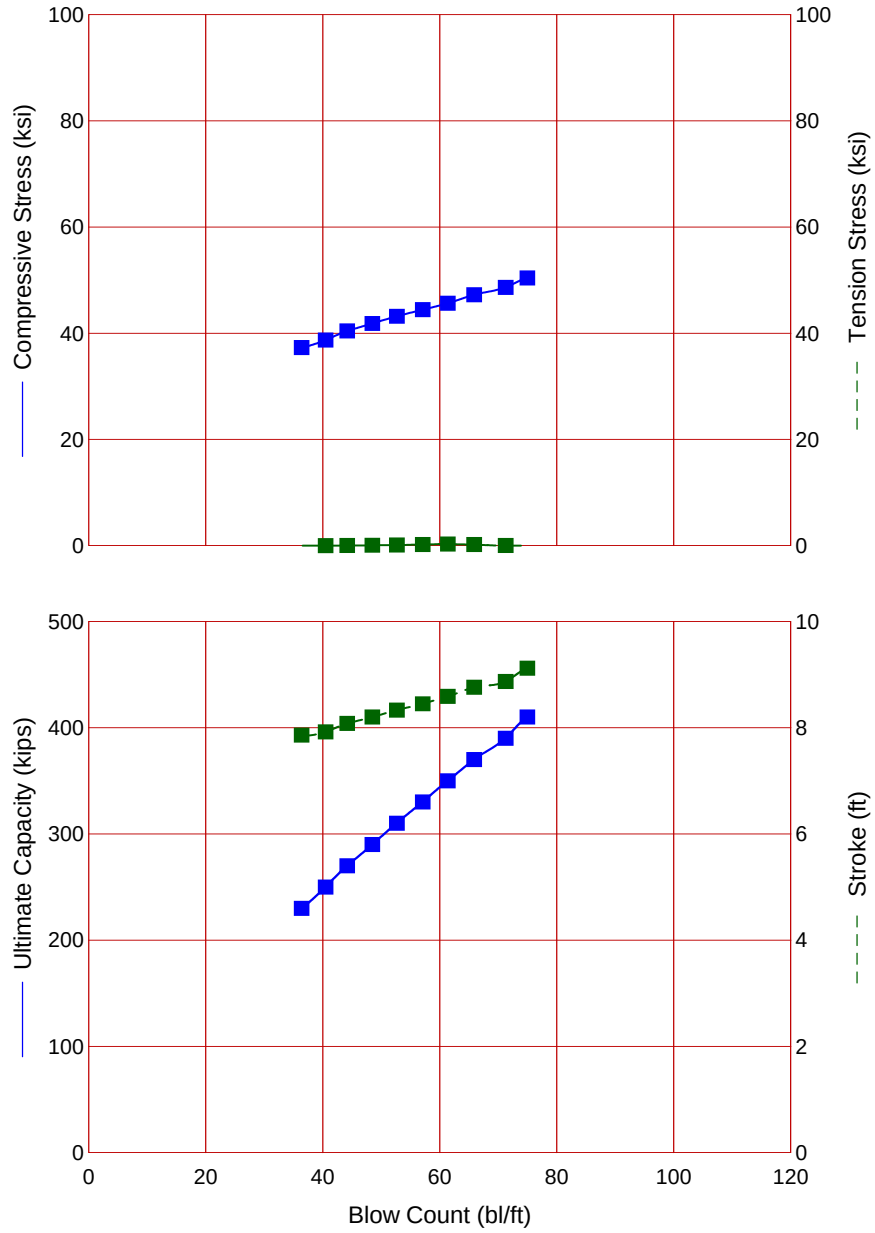
Residual Stress Analysis: No



Press F1 for General Help Topics or F3 for Specific Help on Current Parameters

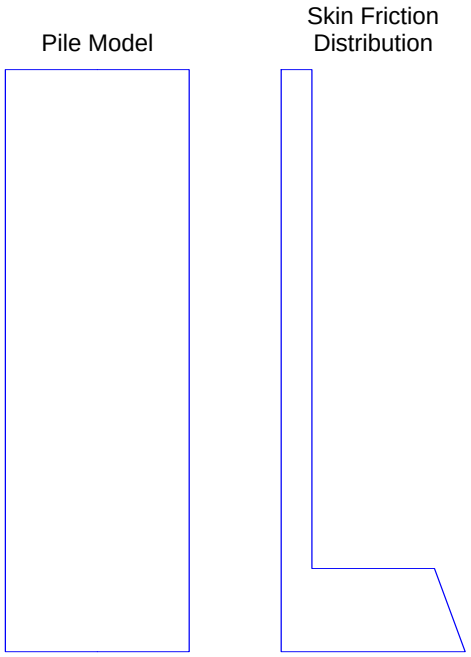
Terracon Consultants Inc
Bridge 238- EB2A

06-Nov-2012
GRLWEAP (TM) Version 2005



DELMAG D 19-42

Efficiency	0.800	
Helmet	1.90	kips
Hammer Cushion	60155	kips/in
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.130	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	14.00	ft
Pile Penetration	14.00	ft
Pile Top Area	15.50	in2



Res. Shaft = 6 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
230.0	37.29	0.00	36.4	7.86	15.39
250.0	38.72	0.01	40.5	7.92	15.13
270.0	40.42	0.05	44.2	8.08	15.10
290.0	41.83	0.08	48.5	8.20	14.96
310.0	43.17	0.13	52.7	8.33	15.08
330.0	44.42	0.22	57.1	8.45	15.21
350.0	45.63	0.31	61.4	8.59	15.43
370.0	47.25	0.20	65.9	8.76	15.66
390.0	48.63	0.02	71.3	8.87	15.74
410.0	50.40	0.00	75.0	9.12	16.20

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. EB2-B	**STATION** 13+01	**OFFSET** 18 ft RT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 684.6 ft	**TOTAL DEPTH** 21.9 ft	**NORTHING** 829,341	**EASTING** 1,782,637	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/07/12	**COMP. DATE** 06/07/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
685										ELEV. (ft) DEPTH (ft)
										684.6 GROUND SURFACE 0.0
										ROADWAY EMBANKMENT Orange and brown, sandy CLAY
680	681.1	3.5	2	1	1	2		M		
	676.1	8.5	WOH	WOH	WOH	0		M		BOC ~ 677.76
675					WOH					
										672.6 12.0
	671.1	13.5	WOH	WOH	WOH	0		M		**ALLUVIAL** Gray, sandy CLAY
670					WOH					
										667.6 17.0
	666.1	18.5	16	8	17	25		W		**RESIDUAL** Green and brown, sandy SILT
665										
	662.7	21.9	60/0			60/0				662.7 21.9
										Tip ~ 661
										Boring Terminated with Standard Penetration Test Refusal at Elevation 662.7 ft on Crystalline Rock (Metamorphosed Granite)
										1) Advanced 3-7/8" tricone carb. bit to 21.9 feet. 2) Used creek water and bentonite as drilling fluid.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/8/12

GRLWEAP 2005-2-Terracon Consultants Inc - [Bridge 238- EB2B.gww]

File Edit View Options Tools Window Help

English | Simple Resistance Distr | Uniform Pile | Bearing Graph - prop. shaft resistance

Bridge 238- EB2B

Hammer Information

Select from following list [8/28/2009-2003]: ID: 41

ID	Name	Type	Ram Wt	Energy/Power
39	DELMAG D 14-42	OED	3.086	34.501
40	DELMAG D 19-32	OED	4.000	42.440
41	DELMAG D 19-42	OED	4.000	43.240

Hammer parameters

Efficiency	0.8			
Pressure	1520.0	psi	Fixed	100 %
Stroke	10.81	ft	Variable	of Max

Pile material

Concrete (○) Steel (●) Timber (○)

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	17.	ft	Auto	Segments
Penetration	17.	ft	Auto.	S-Length
Section Area	15.5	in^2	Auto.	S-St. Wt
Elast Modulus	30000.	ksi		
Spec Weight	492.0	lb/ft^3		
Toe Area	144.	in^2	0	Splices
Perimeter	4.	ft	Pile Type:	
Pile Size	12.	in	H Pile	

Ultimate Capacities (up to 10)

kips

1	230.0	6	330.0
2	250.0	7	350.0
3	270.0	8	370.0
4	290.0	9	390.0
5	310.0	10	410.0

Incr. 0 Action >>

Soil Parameters

Quake

Shaft 0.1 in Const

Toe 0.1 in

Damping

Shaft 0.092 s/ft Const

Toe 0.15 s/ft Smith

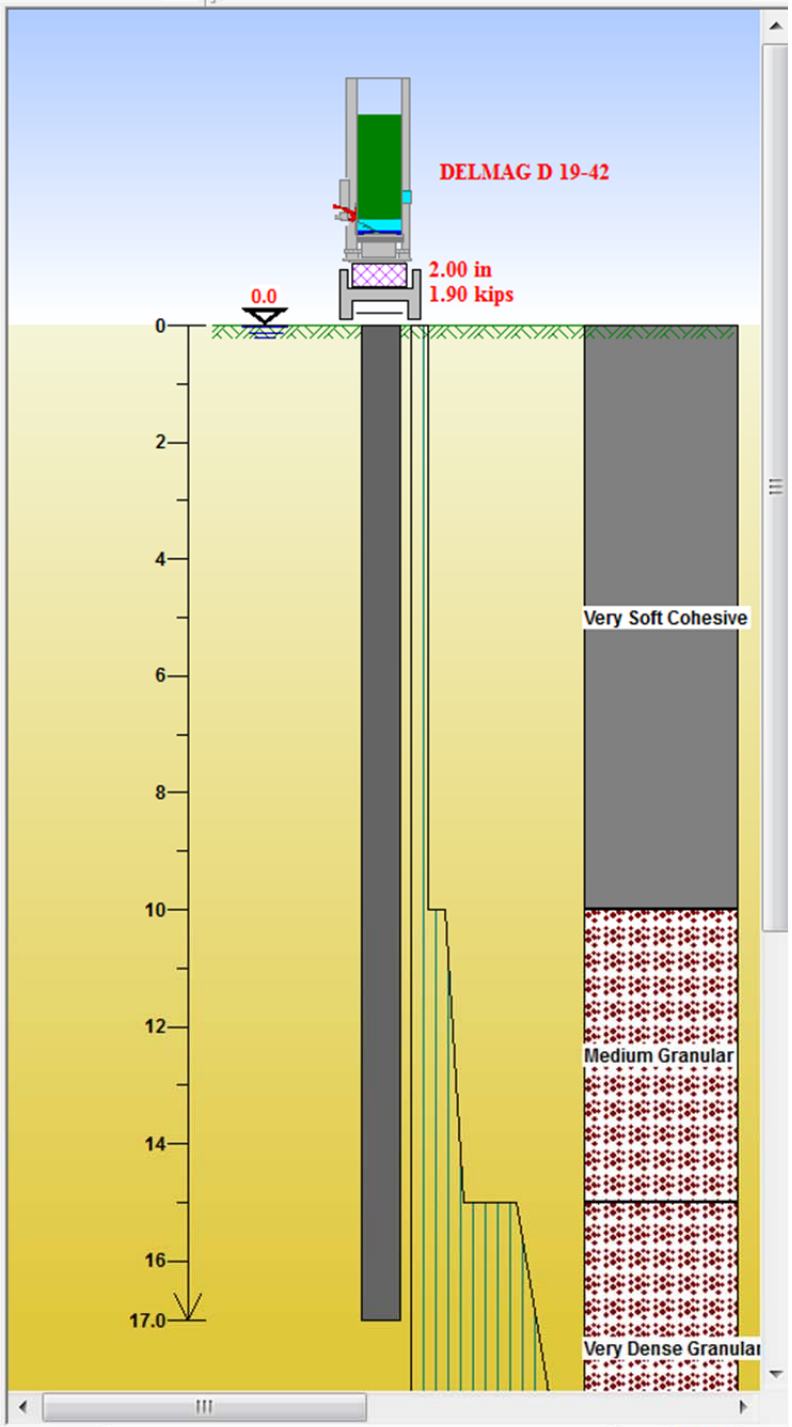
Shaft Resistance

Percentage 8 %

100%

Dist. Shape Numb 0.0

Residual Stress Analysis: No

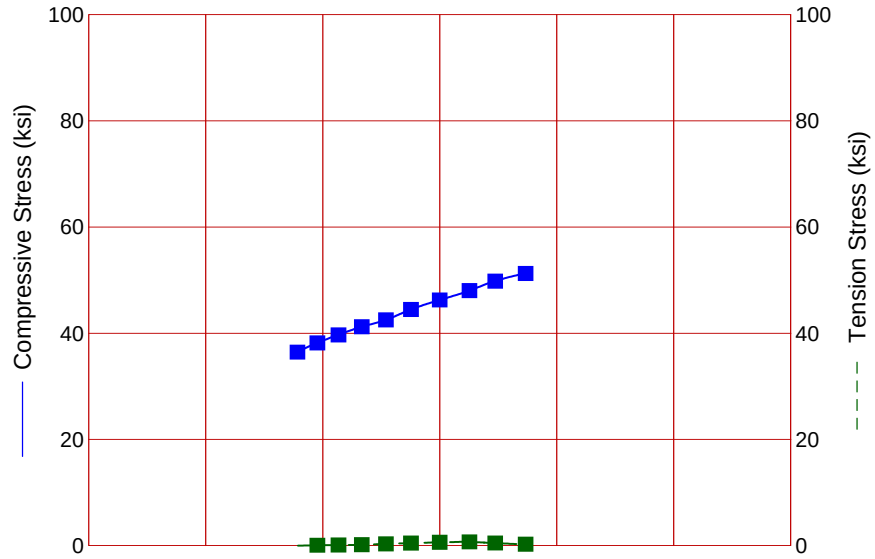


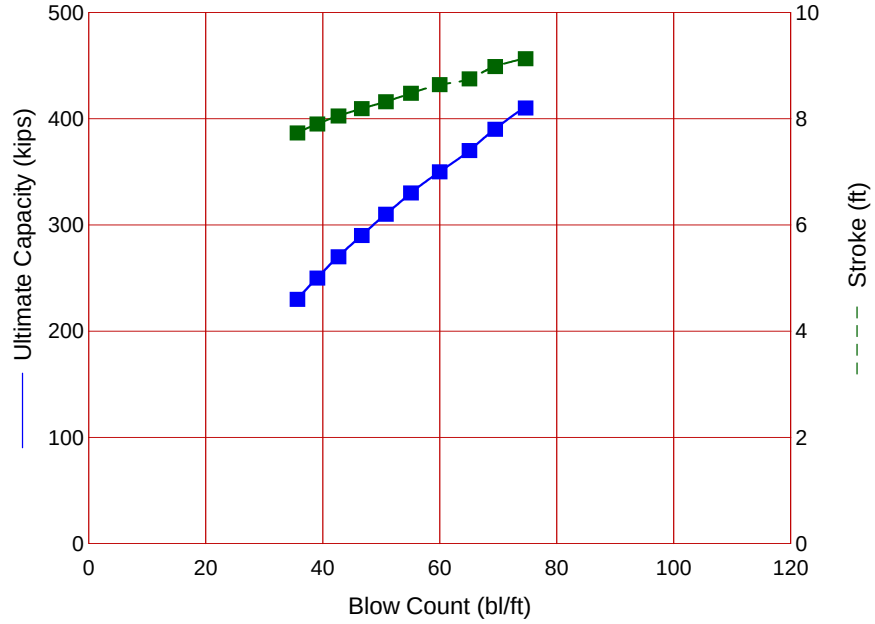
Press F1 for General Help Topics or F3 for Specific Help on Current Parameters

NUM

Terracon Consultants Inc
Bridge 238- EB2B

06-Nov-2012
GRLWEAP (TM) Version 2005



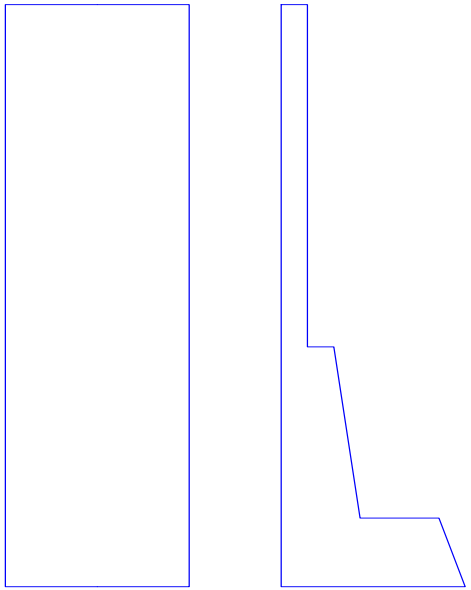


DELMAG D 19-42

Efficiency	0.800	
Helmet	1.90	kips
Hammer Cushion	60155	kips/in
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.092	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	17.00	ft
Pile Penetration	17.00	ft
Pile Top Area	15.50	in2

Pile Model

Skin Friction Distribution



Res. Shaft = 8 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
230.0	36.43	0.00	35.7	7.73	15.52
250.0	38.16	0.08	39.1	7.90	15.53
270.0	39.69	0.12	42.7	8.05	15.54
290.0	41.21	0.19	46.7	8.19	15.55
310.0	42.50	0.35	50.8	8.32	15.70
330.0	44.47	0.49	55.1	8.48	15.95
350.0	46.26	0.63	60.0	8.64	16.13
370.0	48.01	0.71	65.1	8.75	16.31
390.0	49.81	0.50	69.5	8.98	16.69
410.0	51.24	0.27	74.7	9.13	16.90

APPENDIX B – INTERIOR BENT ANALYSES

APPENDIX B-1 – BENT 1, BORING B1-A

BORING B1-A WITH RELEVANT ELEVATIONS
AXIAL CALCULATIONS
L-PILE ANALYSES
REQUIRED TIP RESISTANCE CALCULATIONS

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B1-A	**STATION** 12+14	**OFFSET** 4 ft LT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 683.1 ft	**TOTAL DEPTH** 19.5 ft	**NORTHING** 829,405	**EASTING** 1,782,574	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** H.S. Augers		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
685											
										683.1 GROUND SURFACE	0.0
										682.4 Asphalt (0.7 ft)	0.7
680										681.2 Concrete (1.2 ft)	1.9
	679.6	3.5	3	7	7	14		M		**ROADWAY EMBANKMENT** Brown sandy CLAY	
						B.O.C. ~ 676.5					
675	674.6	8.5	4	1	1	2		M		676.1 **ALLUVIAL** Red-orange sandy CLAY with brown clayey SAND seams	7.0
						T.O.S. ~ 673					
670	669.6	13.5	2	2	15	17 Scour ~ 668		W		668.1 **WEATHERED ROCK** (Green-gray Metamorphosed Granite)	15.0
665	664.6	18.5									
	663.6	19.5	100/0.3 60/0			100/0.3 60/0				663.6	19.5
						P.O.F. ~ 660.5				Boring Terminated with Standard Penetration Test Refusal at Elevation 663.6 ft on Crystalline Rock (Metamorphosed Granite)	
						TIP ~ 659.6				1) Advanced 3-1/4" HSA to 19.5 feet. 2) Hard drilling at 15 feet.	

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/8/12

Terracon

Analysis Performed By:	*JPM*
Date of Analysis:	*11/8/2012*
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT TIP RESISTANCE IN SOIL, IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1A*	
Boring Elevation:	*673.00*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	*ft*
Shaft Length:	*13.5*	*ft (below grade)*	**Tip Elevation:**	*659.50*	*ft MSL*	**Cross-section Area:**	*7.1*	*ft²*
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	*ft*

Type of Material at the Tip:	**Rock**

f_c': concrete compressive strength =	**4.50**	ksi

For Soil Section 10.8.3.5.2c, *2010 AASHTO LRFD Bridge Design Specifications*

Cohesionless Soils: $N_{60} \le 50$, $q_p = 1.2*N_{60}$ Equation 10.8.3.5.2c-1, *2010 AASHTO LRFD Bridge Design Specifications*

Cohesive Soils: $N_c = 6(1+0.2(Z/D)) \le 9$ $q_p = N_c * S_u \le 80$ where Z= penetration of shaft in bearing layer

S_u = ksf

Z = ft

N_c =

Cohesionless Soils: **Unit Tip Resistance in Soil, q_p =** (q_p is limited to a maximum of 60 ksf)

Cohesive Soils: **Unit Tip Resistance in Soil, q_p =** (q_p is limited to a maximum of 80 ksf)

For IGM (IGM: Cohesionless soils with blow counts greater than 50 blows/ft, i.e., Very Dense/Hard Soils and PWR)
Section 10.8.3.5.2c, *2010 AASHTO LRFD Bridge Design Specifications*

$$q_p = 0.59 \left[N_{60} \left\{ \frac{p_a}{\sigma'_v} \right\} \right]^{0.8} \sigma'_v$$

Equation 10.8.3.5.2c-2, *2010 AASHTO LRFD Bridge Design Specifications*

Material unit weight at tip =	0.14	kcf		Depth of the tip:	13.5	ft	Water Level (ft):	0 ft
N: Uncorrected SPT Blow Count at the Tip =	1000	blows/ft		N_{60}* = (ER/60%)N =	100	blows/ft	Type of Hammer:	auto
p_a: atmospheric pressure =	2.12	ksf		σ'_v : vertical effective stress at tip =	0.85	ksf	ER: Hammer Efficiency:	80%

*N_{60} is limited to a maximum of 100 bpf

Unit Tip Resistance in IGM, q_p =

For Rock

$q_p = A + q_u [m_b (A/q_u) + s]^a$ where $A = \sigma'_v + q_u [m_b (\sigma'_v/q_u) + s]^a$

Reference: Turner (2006). *NCHRP Synthesis 360 Rock-Socketed Shafts for Highways Structure Foundations* . Transportation Research Board of National Academies. 136 pp.

q_u: unconfined compressive strength of intact rock — s, a : constant for the Rock Mass — GSI: Geological Strength Index — $GSI^* \approx 18.7e^{(0.0152RQD)}$

m_b: Reduced Value of m_i — $s = \exp^{((GSI-100)/9)}$ — $m_b = m_i (\exp^{((GSI-100)/28)})$ — $a = 1/2 + 1/6(e^{-GSI/15} - e^{-20/3})$ — RQD: Rock Quality Designation

q_u =	1,152	ksf	m_i =	29		RQD =	48	%	A =	64.66	ksf
GSI =	39	s =	1.11E-03	a =	0.51	m_b =	3.26				

* Correlation defined by Truzman et. al. (2011) "Determination of Unit Tip Resistance for Drilled Shafts in Fractured Rocks using the Global Rock Mass Strength", 2011 Pan-Am CGS Geotechnical Conference

Unit Tip Resistance in Rock, q_p = 549 ksf in Rock < fc' = 648 ksf

NOTE: Please input the required data where indicated in Blue. When calculating Tip Resistance in Cohesive Soil, please input an Undrained Shear Strength value, Su, into the "Side in Soils (using a-method)" sheet for the bearing layer to generate a tip resistance in cohesive soils output on this sheet. When calculating Tip Resistance in IGM, no data needs to be input onto this sheet other than indicating IGM or Rock as the material at the tip, and the Project Information at the top of the sheet. Please input all soil strata data and shaft information into the "Side in Soils (using B-method)" sheet to generate a tip resistance in IGM output on this sheet. You should always check the input and output values on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/8/2012***
Analysis Reviewed By:	

DRILLED SHAFT SIDE RESISTANCE CALCULATION USING β-METHOD

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*13.5*	*ft (below grade)*	**Tip Elevation:**	*659.5*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*			

UNIT SIDE RESISTANCE (q_s) (*Section 10.8.3.5.2b, 2010 AASHTO LRFD Bridge Design Specifications*)

$q_s = \beta\sigma_v'$ ≤ 4.0 ksf for 0.25 ≤ β ≤ 1.2 (Eq. 10.8.3.5.2b-1)

For N_{60} ≤ 15	$\beta = (1.5 - 0.135\,(z)^{0.5})\,N_{60}/15$		
For N_{60} ≥ 15	$\beta = 1.5 - 0.135\,(z)^{0.5}$ (sandy soils)	or	$\beta = 2.0 - 0.06\,(z)^{0.75}$ (gravelly sands and gravels)
N_{60} = (ER/60%)N	N_{60}: SPT blow count corrected for hammer efficiency (blows/ft)		N: uncorrected SPT blow count
σ'_v = vertical effective stress	Hammer efficiency = 80%	Type of Hammer: auto	Water Level (ft): 0 ft

# of Layers:	3	Layer the Tip is located in:	3

Layer	USCS	Soil Type	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	β	Check if 0.25<β<1.2	q_s (ksf)	Check if $q_s \le 4.0$ ksf	Q_{si} (kips)
1	CL	Clay	0	5	0.110	2.5	0.119	0	0					
2	PWR	IGM	5	9.5	0.130	7.3	0.390	100	133	1.14	1.14	IGM Mat'l		
3	Rock	Rock	9.5	34.5	0.140	11.5	0.697	1000				Rock		

Total Skin Friction in Soils, $\Sigma(Q_{s,soils})_i$ = 0

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/8/2012***
Analysis Reviewed By:	

DRILLED SHAFT SIDE RESISTANCE CALCULATION USING α-METHOD

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*13.5*	*ft (below grade)*	**Tip Elevation:**	*659.5*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*			

UNIT SIDE RESISTANCE (q_s) (*Section 10.8.3.5.1b, 2010 AASHTO LRFD Bridge Design Specifications*)

$q_s = \alpha S_u$ (Eq. 10.8.3.5.1b-1)

For $S_u/p_a \leq 1.5$	$\alpha = 0.55$			
For $1.5 \leq S_u/p_a \leq 2.5$	$\alpha = 0.55 - 0.1(S_u/p_a - 1.5)$	Su = undrained shear strength (ksf)	α = adhesion factor	p_a = atm. pressure = 2.12 ksf
N_{60} = (ER/60%)N	N_{60}: SPT blow count corrected for hammer efficiency (blows/ft)			N: uncorrected SPT blow count
σ'_v = vertical effective stress	Hammer efficiency = 80%	Type of Hammer: auto		Water Level (ft): 0 ft

# of Layers:	3	Layer the Tip is located in:	3											
Layer	USCS	Soil Type	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	S_u (ksf)	S_u/p_a	α	q_s (ksf)	Q_{si} (kips)
1	CL	Clay	0	5	0.110	2.5	0.119	0	0	0.00	0.00	0.55	0.00	0
2	PWR	IGM	5	9.5	0.130	7.3	0.390	100	133	0.00	0.00	IGM Mat'l		
3	Rock	Rock	9.5	34.5	0.140	11.5	0.697	1000				Rock		

Total Skin Friction in Soils, $\Sigma(Q_{s,soils})_i$ = 0

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/8/2012***
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR WEAK ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*13.5*	*ft (below grade)*	**Tip Elevation:**	*659.5*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	ft

UNIT SIDE RESISTANCE (q_s) for COHESIONLESS IGM SOILS (*Section 10.8.3.5.5, 2010 AASHTO LRFD Bridge Design Specifications*)

$$q_s = \sigma'_v K_o \tan \Phi'$$

Equation referenced from Chapter 11, *Drilled Shafts: Construction Procedures and Design Methods*, FHWA Publication No. FHWA-IF-99-025, O'Neill and Reese, August, 1999.

IGM: Very Hard/Very Dense Cohesionless Soils and PWR with SPT N_{60} > 50 blows-per-foot		N_{60} = (ER/60%)N = SPT N-value corrected for Hammer Efficiency		
$\Phi' = \tan^{-1}((N_{60}/(12.3+20.3(\sigma'_v/p_a)))^{0.34}$	Φ' = effective stress friction angle of IGM	N: Uncorrected SPT N-Value along the shaft		
$K_o = (1-\sin\Phi')OCR^{\sin\Phi'}$	K_o = in-situ coefficient of lateral earth pressure	Hammer Efficiency, ER =	80%	
$OCR = \sigma'_p/\sigma'_v$	σ'_v = vertical effective stress	Type of hammer =	auto	
$\sigma'_p = 0.2N_{60}p_a$	σ'_p = vertical effective stress	Atmospheric Pressure, p_a =	2.12	ksf

# of Layers: 3

Layer	Material	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	ϕ' (degrees)	σ'_p (ksf)	OCR	K_o	q_s ** (ksf)	Q_s (kips)
1	CL	0	5	0.110	2.5	0.119	0	0				Not IGM		
2	PWR	5	9.5	0.130	7.3	0.390	100	133	61.8	42.400	108.69	7.40	2.7	114
3	Rock	9.5	34.5	0.140	11.5	0.697	1000					Not IGM		

***Unit Side Resistance, qs, has been reduced by 50% of its calculated value based on past local experience in IGM Materials.**

Total Skin Friction in IGM, $\Sigma(Q_{s,IGM})_i$ = 114

NOTE: No data needs to be input on this sheet to calculate skin resistance in IGM. Please input all soil strata information into the "Side in Soils" sheet to generate a skin resistance in IGM output on this sheet. You should always check the input and output information on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/8/2012***

Analysis Reviewed By:

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*13.5*	*ft (below grade)*	**Tip Elevation:**	*659.5*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	ft

UNIT SIDE RESISTANCE (q_s) for DRILLED SHAFTS in ROCK (*Section 10.8.3.5.4b, 2010 AASHTO LRFD Bridge Design Specifications*)

$$q_s = 0.65\,\alpha_E\,p_a\,(q_u/p_a)^{0.5} < 7.8\,p_a\,(f_c'/p_a)^{0.5}$$ (Equation 10.8.3.5.4b-1)

For Rock Layer 1

p_a: atmospheric pressure =		2.12	ksf	f_c': concrete compressive strength =		4.50	ksi
q_u: unconfined compressive strength of rock =		1152	ksf	E_m/E_i: reduction factor (determined from Table 10.4.6.5-1) =		0.07	
RQD =	30 %	GSI =	28	α_E = reduction factor to account for jointing in rock =		0.48	

q_s = 15.53 ksf ≤ 24.09 ksf

calculation of qs is OK **use qs = 15.53 ksf for Rock Layer 1**

For Rock Layer 2

p_a: atmospheric pressure =		2.12	ksf	f_c': concrete compressive strength =		4.50	ksi
q_u: unconfined compressive strength of rock =			ksf	E_m/E_i: reduction factor (determined from Table 10.4.6.5-1) =		0.05	
RQD =	%	GSI =		α_E = reduction factor to account for jointing in rock =		0.45	

q_s = 0.00 ksf ≤ 24.09 ksf

calculation of qs is OK **use qs = 0.00 ksf for Rock Layer 2**

AREA OF SHAFT SIDE SURFACE (As) in ROCK

Length in Layer 1 =	4	ft
Length in Layer 2 =		ft
Socket Diameter =	2.8333	ft
Socket perimeter =	8.90	ft

A_s = 35.60 ft^2

Total Skin Friction in Rock, $Q_{s,rock}$ = 553 kips

NOTE: When calculating side resistance in Rock on this sheet, please input the required input data where indicated in Blue. Please input all rock/soil data and shaft information correctly into the "Tip" sheet to generate a Skin Resistance in Rock output on this sheet. You should always check the input and output values on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/8/2012***
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*13.5*	*ft (below grade)*	**Tip Elevation:**	*659.5*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	0.0	ft

Table 10.5.5.2.4-1 Resistance Factors for Geotechnical resistance of Drilled Shafts (2010 AASHTO LRFD Bridge Design Specifications)

Method/Soil/Condition			Resistance Factor
Nominal Axial Compressive Resistance of Single-Drilled Shafts, φ_{stat}	Side resistance in clay	α-method (O'Neill and Reese, 1999)	0.45
	Tip resistance in clay	Total Stress (O'Neill and Reese, 1999)	0.40
	Side resistance in sand	β-method (O'Neill and Reese, 1999)	0.55
	Tip resistance in sand	O'Neill and Reese (1999)	0.50
	Side resistance in IGMs	O'Neill and Reese (1999)	0.60
	Tip resistance in IGMs	O'Neill and Reese (1999)	0.55
	Side resistance in rock	Horvath and Kenney (1979)	0.5
	Tip resistance in rock	O'Neill and Reese (1999)	0.50
Static Load Test (compression), φ_{load}	All Materials		Values in Table 10.5.5.2.3-2, but no greater than 0.70

Nominal Shaft Tip Resistance (R_p)

$R_p = q_p \times A_p$ (Equation 10.8.3.5-2)

q_p = 549 ksf A_p = 6.30 ft^2 **R_p = 3,459 kips** ***(In Rock)***

Nominal Shaft Side Resistance (R_s)

$R_s = q_s \times A_s$ (Equation 10.8.3.5-3)

$R_{s,clay}$ = 0 kips **$R_{s,sand}$ = 0 kips** **$R_{s,IGM}$ = 114 kips** **$R_{s,rock}$ = 553 kips**

Total Nominal Resistance ($R_p + R_s$) = 4,126 kips equivalent to **18,354 kN**

REDUCTION DUE TO GROUP EFFECTS

$0.65 \le \eta \le 1.00$ for $2.5*dia. \le$ Distance Between Shafts $\le 6*dia.$ (Section 10.8.3.6.3)

Distance Between Shafts = 18 **feet** **η = 1.00**

FACTORED RESISTANCE OF SINGLE DRILLED SHAFT

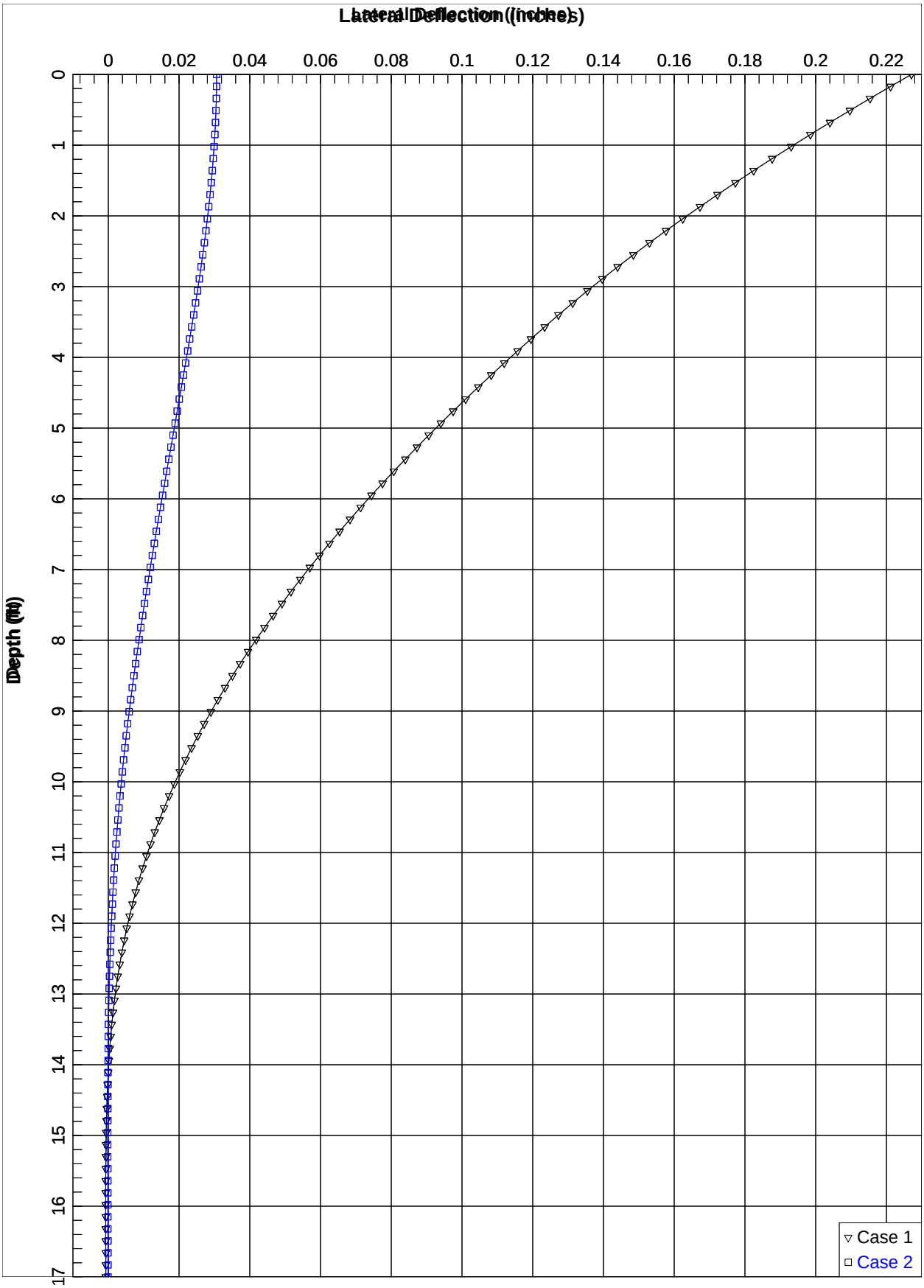
$R_R = \varphi R_n = \varphi_{qp} R_p + \varphi_{qs} R_s$ (Equation 10.8.3.5-1)

φ_{qp} = resistance factor for tip resistance specified in Table 10.5.5.2.4-1

φ_{qs} = resistance factor for shaft side resistance specified in Table 10.5.5.2.4-1

φ_{qp} =	0.50	Rock									
φ_{qs} =	0.45	Clay	φ_{qs} =	0.55	Sand	φ_{qs} =	0.60	IGM	φ_{qs} =	0.55	Rock

Total Factored Resistance, R_R = 2,102 kips


Lateral Deflection (inches)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Case 1
Case 2

LPile Plus for Windows, Version 6 (6.0.28)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Serial Number of Security Device: 156316250
Company Name Stored in Security Device: WPC, Inc.

Files Used for Analysis

Path to file locations: N:\Projects\2011\71115060\Working Files\Bridge 238\Calculations-Analyses\
Name of input data file: Bridge 238 - B1A.lp6d
Name of output report file: Bridge 238 - B1A.lp6o
Name of plot output file: Bridge 238 - B1A.lp6p
Name of runtime messeage file: Bridge 238 - B1A.lp6r

Date and Time of Analysis

Date: November 8, 2012 Time: 8:40:08

Problem Title

Low Impact Bridge - Guilford County No. 238

71115060

KHA

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Boring B1A - Bent 1

Program Options

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes pile response to lateral loading and will compute nonlinear moment-curvature and nominal moment capacity for selected section types.

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total Number of Sections = 2

Total Pile Length = 17.00 ft

Depth of ground surface below top of pile = 8.50 ft

Pile dimensions used for p-y curve computations defined using 4 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	30.0000000
2	3.500000	30.0000000

3	3.500000	36.0000000
4	17.000000	36.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	3.500 ft
Top Width	=	30.000 in
Bottom Width	=	30.000 in
Top Area	=	706.858347 sq. in
Bottom Area	=	706.858347 sq. in
Moment of Inertia at Top	=	39760.782 in^4
Moment of Inertia at Bottom	=	39760.782 in^4
Elastic Modulus	=	3283676. lbs/in^2

Pile Section No. 2:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	13.500 ft
Top Width	=	36.000 in
Bottom Width	=	36.000 in
Top Area	=	1017.876020 sq. in
Bottom Area	=	1017.876020 sq. in
Moment of Inertia at Top	=	82447.958 in^4
Moment of Inertia at Bottom	=	82447.958 in^4
Elastic Modulus	=	3283676. lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer = 8.500 ft
Distance from top of pile to bottom of layer = 13.000 ft

Layer 2 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 13.000 ft
Distance from top of pile to bottom of layer = 34.500 ft

(Depth of lowest layer extends 17.50 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	8.50	70.00000
2	13.00	70.00000
3	13.00	80.00000
4	34.50	80.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	J	kpy pci	Rock Emass psi	Depth ft	Eff. Unit Wt., pcf	krm	Cohesion Test Type	Friction Test Prop.	Elas. Subgr. Ang., deg.	qu psi	RQD percent	Epsilon 50
1	Stiff Clay w/o Free Water	--	--	--	8.500	70.000	4000.000	--	--	--	--	--	5.00E-04
					13.000	70.000	4000.000	--	--	--	--	--	5.00E-04
2	Vuggy Limestone	--	--	--	13.000	80.000	--	--	--	--	5000.000	--	--
					34.500	80.000	--	--	--	--	5000.000	--	--

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 15000. lbs	M = 2760000. in-lbs	581000.
2	2	V = 21000. lbs	S = 0.0000 in/in	368000.

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Moment-Curvature properties derived from elastic section properties

Pile Section No. 2:

Moment-Curvature properties derived from elastic section properties

---

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Horizontal shear force at pile head = 15000.000 lbs
Applied moment at pile head = 2760000.000 in-lbs
Axial thrust load on pile head = 581000.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2271	2760000.	15000.	-0.002912	1863.1739	1.306E+11	0.000	0.000	0.000
2.040	0.2212	2794026.	15000.	-0.002869	1876.0106	1.306E+11	0.000	0.000	0.000
4.080	0.2154	2828001.	15000.	-0.002825	1888.8277	1.306E+11	0.000	0.000	0.000
6.120	0.2097	2861923.	15000.	-0.002781	1901.6251	1.306E+11	0.000	0.000	0.000
8.160	0.2040	2895793.	15000.	-0.002736	1914.4025	1.306E+11	0.000	0.000	0.000
10.200	0.1985	2929609.	15000.	-0.002690	1927.1597	1.306E+11	0.000	0.000	0.000
12.240	0.1931	2963370.	15000.	-0.002644	1939.8964	1.306E+11	0.000	0.000	0.000
14.280	0.1877	2997077.	15000.	-0.002598	1952.6125	1.306E+11	0.000	0.000	0.000
16.320	0.1825	3030728.	15000.	-0.002551	1965.3075	1.306E+11	0.000	0.000	0.000
18.360	0.1773	3064323.	15000.	-0.002503	1977.9814	1.306E+11	0.000	0.000	0.000
20.400	0.1722	3097861.	15000.	-0.002455	1990.6339	1.306E+11	0.000	0.000	0.000
22.440	0.1673	3131342.	15000.	-0.002406	2003.2648	1.306E+11	0.000	0.000	0.000
24.480	0.1624	3164764.	15000.	-0.002357	2015.8737	1.306E+11	0.000	0.000	0.000
26.520	0.1577	3198129.	15000.	-0.002307	2028.4606	1.306E+11	0.000	0.000	0.000
28.560	0.1530	3231434.	15000.	-0.002257	2041.0251	1.306E+11	0.000	0.000	0.000
30.600	0.1485	3264679.	15000.	-0.002206	2053.5670	1.306E+11	0.000	0.000	0.000
32.640	0.1440	3297863.	15000.	-0.002155	2066.0862	1.306E+11	0.000	0.000	0.000
34.680	0.1397	3330987.	15000.	-0.002103	2078.5823	1.306E+11	0.000	0.000	0.000
36.720	0.1354	3364049.	15000.	-0.002051	2091.0551	1.306E+11	0.000	0.000	0.000
38.760	0.1313	3397049.	15000.	-0.001998	2103.5044	1.306E+11	0.000	0.000	0.000
40.800	0.1273	3429985.	15000.	-0.001945	2115.9300	1.306E+11	0.000	0.000	0.000
42.840	0.1234	3462859.	15000.	-0.001905	1326.8061	2.707E+11	0.000	0.000	0.000
44.880	0.1195	3495701.	15000.	-0.001879	1333.9762	2.707E+11	0.000	0.000	0.000
46.920	0.1157	3528512.	15000.	-0.001852	1341.1395	2.707E+11	0.000	0.000	0.000
48.960	0.1119	3561291.	15000.	-0.001825	1348.2959	2.707E+11	0.000	0.000	0.000
51.000	0.1083	3594039.	15000.	-0.001799	1355.4454	2.707E+11	0.000	0.000	0.000
53.040	0.1046	3626755.	15000.	-0.001771	1362.5879	2.707E+11	0.000	0.000	0.000
55.080	0.1010	3659438.	15000.	-0.001744	1369.7233	2.707E+11	0.000	0.000	0.000
57.120	0.0975	3692089.	15000.	-0.001716	1376.8515	2.707E+11	0.000	0.000	0.000
59.160	0.0940	3724706.	15000.	-0.001688	1383.9726	2.707E+11	0.000	0.000	0.000
61.200	0.0906	3757291.	15000.	-0.001660	1391.0864	2.707E+11	0.000	0.000	0.000
63.240	0.0873	3789841.	15000.	-0.001632	1398.1928	2.707E+11	0.000	0.000	0.000
65.280	0.0840	3822358.	15000.	-0.001603	1405.2919	2.707E+11	0.000	0.000	0.000
67.320	0.0807	3854841.	15000.	-0.001574	1412.3836	2.707E+11	0.000	0.000	0.000
69.360	0.0775	3887289.	15000.	-0.001545	1419.4677	2.707E+11	0.000	0.000	0.000
71.400	0.0744	3919703.	15000.	-0.001515	1426.5442	2.707E+11	0.000	0.000	0.000
73.440	0.0713	3952082.	15000.	-0.001486	1433.6131	2.707E+11	0.000	0.000	0.000
75.480	0.0683	3984425.	15000.	-0.001456	1440.6743	2.707E+11	0.000	0.000	0.000
77.520	0.0654	4016733.	15000.	-0.001426	1447.7277	2.707E+11	0.000	0.000	0.000
79.560	0.0625	4049005.	15000.	-0.001395	1454.7733	2.707E+11	0.000	0.000	0.000
81.600	0.0597	4081240.	15000.	-0.001365	1461.8110	2.707E+11	0.000	0.000	0.000
83.640	0.0570	4113440.	15000.	-0.001334	1468.8407	2.707E+11	0.000	0.000	0.000
85.680	0.0543	4145602.	15000.	-0.001303	1475.8624	2.707E+11	0.000	0.000	0.000
87.720	0.0516	4177728.	15000.	-0.001271	1482.8760	2.707E+11	0.000	0.000	0.000
89.760	0.0491	4209816.	15000.	-0.001240	1489.8815	2.707E+11	0.000	0.000	0.000
91.800	0.0466	4241867.	15000.	-0.001208	1496.8788	2.707E+11	0.000	0.000	0.000
93.840	0.0442	4273879.	15000.	-0.001176	1503.8678	2.707E+11	0.000	0.000	0.000
95.880	0.0418	4305854.	15000.	-0.001144	1510.8484	2.707E+11	0.000	0.000	0.000
97.920	0.0395	4337790.	15000.	-0.001111	1517.8207	2.707E+11	0.000	0.000	0.000
99.960	0.0373	4369687.	15000.	-0.001078	1524.7845	2.707E+11	0.000	0.000	0.000
102.000	0.0351	4401546.	13562.	-0.001045	1531.7398	2.707E+11	-1409.4958	81939.	0.000

104.040	0.0330	4427499.	10694.	-0.001012	1537.4059	2.707E+11	-1402.4202	86712.	0.000
106.080	0.0310	4447576.	7841.2144	-0.000978	1541.7892	2.707E+11	-1394.5853	91881.	0.000
108.120	0.0290	4461810.	5005.0438	-0.000945	1544.8968	2.707E+11	-1385.9741	97491.	0.000
110.160	0.0271	4470237.	2187.2504	-0.000911	1546.7364	2.707E+11	-1376.5684	103591.	0.000
112.200	0.0253	4472894.	-610.5248	-0.000877	1547.3166	2.707E+11	-1366.3485	110241.	0.000
114.240	0.0235	4469826.	-3386.5998	-0.000844	1546.6467	2.707E+11	-1355.2936	117509.	0.000
116.280	0.0218	4461077.	-6139.2479	-0.000810	1544.7367	2.707E+11	-1343.3811	125472.	0.000
118.320	0.0202	4446698.	-8866.6948	-0.000777	1541.5975	2.707E+11	-1330.5864	134223.	0.000
120.360	0.0187	4426742.	-11567.	-0.000743	1537.2406	2.707E+11	-1316.8830	143867.	0.000
122.400	0.0172	4401266.	-14239.	-0.000710	1531.6787	2.707E+11	-1302.2418	154532.	0.000
124.440	0.0158	4370331.	-16879.	-0.000677	1524.9251	2.707E+11	-1286.6308	166367.	0.000
126.480	0.0144	4334003.	-19487.	-0.000644	1516.9939	2.707E+11	-1270.0146	179550.	0.000
128.520	0.0131	4292350.	-22060.	-0.000612	1507.9004	2.707E+11	-1252.3539	194295.	0.000
130.560	0.0119	4245448.	-24596.	-0.000579	1497.6607	2.707E+11	-1233.6046	210863.	0.000
132.600	0.0108	4193374.	-27092.	-0.000548	1486.2919	2.707E+11	-1213.7169	229571.	0.000
134.640	0.009700	4136211.	-29546.	-0.000516	1473.8122	2.707E+11	-1192.6344	250811.	0.000
136.680	0.008679	4074049.	-31956.	-0.000485	1460.2409	2.707E+11	-1170.2921	275072.	0.000
138.720	0.007721	4006979.	-34320.	-0.000455	1445.5983	2.707E+11	-1146.6147	302970.	0.000
140.760	0.006824	3935102.	-36633.	-0.000425	1429.9062	2.707E+11	-1121.5138	335294.	0.000
142.800	0.005987	3858523.	-38894.	-0.000396	1413.1874	2.707E+11	-1094.8848	373070.	0.000
144.840	0.005210	3777353.	-41099.	-0.000367	1395.4663	2.707E+11	-1066.6013	417652.	0.000
146.880	0.004491	3691710.	-43244.	-0.000339	1376.7688	2.707E+11	-1036.5086	470867.	0.000
148.920	0.003828	3601721.	-45326.	-0.000311	1357.1224	2.707E+11	-1004.4136	535241.	0.000
150.960	0.003221	3507519.	-47340.	-0.000284	1336.5564	2.707E+11	-970.0696	614361.	0.000
153.000	0.002668	3409249.	-49281.	-0.000258	1315.1022	2.707E+11	-933.1522	713504.	0.000
155.040	0.002167	3307066.	-51144.	-0.000233	1292.7935	2.707E+11	-893.2213	840767.	0.000
157.080	0.001717	3201135.	-60813.	-0.000208	1269.6668	2.707E+11	-8586.8984	10200000.	0.000
159.120	0.001317	3059441.	-76287.	-0.000185	1238.7322	2.707E+11	-6583.4631	10200000.	0.000
161.160	0.000963	2890322.	-87914.	-0.000162	1201.8101	2.707E+11	-4815.1709	10200000.	0.000
163.200	0.000654	2701138.	-96160.	-0.000141	1160.5076	2.707E+11	-3269.0236	10200000.	0.000
165.240	0.000386	2498325.	-101463.	-0.000122	1116.2297	2.707E+11	-1930.4808	10200000.	0.000
167.280	0.000157	2287457.	-104232.	-0.000104	1070.1929	2.707E+11	-783.9548	10200000.	0.000
169.320	-3.735E-05	2073305.	-104841.	-8.736E-05	1023.4395	2.707E+11	186.7615	10200000.	0.000
171.360	-0.000200	1859912.	-103632.	-7.254E-05	976.8516	2.707E+11	998.1272	10200000.	0.000
173.400	-0.000333	1650657.	-100915.	-5.931E-05	931.1670	2.707E+11	1666.5435	10200000.	0.000
175.440	-0.000442	1448322.	-96962.	-4.764E-05	886.9934	2.707E+11	2208.0933	10200000.	0.000
177.480	-0.000528	1255163.	-92019.	-3.745E-05	844.8230	2.707E+11	2638.3277	10200000.	0.000
179.520	-0.000594	1072973.	-86296.	-2.868E-05	805.0474	2.707E+11	2972.0926	10200000.	0.000
181.560	-0.000645	903142.	-79977.	-2.123E-05	767.9699	2.707E+11	3223.3907	10200000.	0.000
183.600	-0.000681	746717.	-73216.	-1.502E-05	733.8193	2.707E+11	3405.2749	10200000.	0.000
185.640	-0.000706	604457.	-66142.	-9.928E-06	702.7612	2.707E+11	3529.7679	10200000.	0.000
187.680	-0.000722	476881.	-58862.	-5.854E-06	674.9089	2.707E+11	3607.8034	10200000.	0.000
189.720	-0.000730	364315.	-51460.	-2.685E-06	650.3335	2.707E+11	3649.1867	10200000.	0.000
191.760	-0.000733	266932.	-44002.	-3.063E-07	629.0730	2.707E+11	3662.5693	10200000.	0.000
193.800	-0.000731	184789.	-36537.	1.396E-06	611.1396	2.707E+11	3655.4361	10200000.	0.000
195.840	-0.000727	117857.	-29102.	2.536E-06	596.5270	2.707E+11	3634.1002	10200000.	0.000
197.880	-0.000721	66048.	-21719.	3.229E-06	585.2159	2.707E+11	3603.7061	10200000.	0.000
199.920	-0.000714	29235.	-14404.	3.588E-06	577.1789	2.707E+11	3568.2356	10200000.	0.000
201.960	-0.000706	7271.1049	-7163.2155	3.725E-06	572.3839	2.707E+11	3530.5182	10200000.	0.000
204.000	-0.000698	0.000	0.000	3.753E-06	570.7964	2.707E+11	3492.2420	5100000.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.2270806	inches
Computed slope at pile head	=	-0.0029125	radians
Maximum bending moment	=	4472894.	inch-lbs
Maximum shear force	=	-104841.	lbs
Depth of maximum bending moment	=	112.2000000	inches below pile head
Depth of maximum shear force	=	169.3200000	inches below pile head
Number of iterations	=	8	
Number of zero deflection points	=	1	

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head	=	21000.000	lbs
Rotation of pile head	=	0.000E+00	radians
Axial load at pile head	=	368000.000	lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0306	-1302216.	21000.	0.000	1011.8824	1.306E+11	0.000	0.000	0.000
2.040	0.0306	-1259368.	21000.	-2.001E-05	995.7179	1.306E+11	0.000	0.000	0.000
4.080	0.0305	-1216506.	21000.	-3.935E-05	979.5478	1.306E+11	0.000	0.000	0.000
6.120	0.0304	-1173629.	21000.	-5.803E-05	963.3723	1.306E+11	0.000	0.000	0.000
8.160	0.0303	-1130739.	21000.	-7.603E-05	947.1916	1.306E+11	0.000	0.000	0.000
10.200	0.0301	-1087835.	21000.	-9.336E-05	931.0059	1.306E+11	0.000	0.000	0.000
12.240	0.0299	-1044918.	21000.	-0.000110	914.8154	1.306E+11	0.000	0.000	0.000
14.280	0.0297	-1001990.	21000.	-0.000126	898.6203	1.306E+11	0.000	0.000	0.000
16.320	0.0294	-959049.	21000.	-0.000141	882.4207	1.306E+11	0.000	0.000	0.000
18.360	0.0291	-916098.	21000.	-0.000156	866.2169	1.306E+11	0.000	0.000	0.000
20.400	0.0288	-873135.	21000.	-0.000170	850.0091	1.306E+11	0.000	0.000	0.000
22.440	0.0284	-830162.	21000.	-0.000183	833.7974	1.306E+11	0.000	0.000	0.000
24.480	0.0280	-787180.	21000.	-0.000196	817.5820	1.306E+11	0.000	0.000	0.000
26.520	0.0276	-744188.	21000.	-0.000208	801.3631	1.306E+11	0.000	0.000	0.000
28.560	0.0272	-701188.	21000.	-0.000219	785.1409	1.306E+11	0.000	0.000	0.000
30.600	0.0267	-658179.	21000.	-0.000230	768.9156	1.306E+11	0.000	0.000	0.000
32.640	0.0262	-615163.	21000.	-0.000240	752.6874	1.306E+11	0.000	0.000	0.000
34.680	0.0257	-572139.	21000.	-0.000249	736.4565	1.306E+11	0.000	0.000	0.000
36.720	0.0252	-529109.	21000.	-0.000258	720.2231	1.306E+11	0.000	0.000	0.000
38.760	0.0247	-486072.	21000.	-0.000266	703.9873	1.306E+11	0.000	0.000	0.000
40.800	0.0241	-443030.	21000.	-0.000273	687.7494	1.306E+11	0.000	0.000	0.000

42.840	0.0236	-399983.	21000.	-0.000278	448.8612	2.707E+11	0.000	0.000	0.000
44.880	0.0230	-356933.	21000.	-0.000281	439.4626	2.707E+11	0.000	0.000	0.000
46.920	0.0224	-313881.	21000.	-0.000283	430.0636	2.707E+11	0.000	0.000	0.000
48.960	0.0218	-270828.	21000.	-0.000285	420.6642	2.707E+11	0.000	0.000	0.000
51.000	0.0213	-227773.	21000.	-0.000287	411.2645	2.707E+11	0.000	0.000	0.000
53.040	0.0207	-184717.	21000.	-0.000289	401.8644	2.707E+11	0.000	0.000	0.000
55.080	0.0201	-141659.	21000.	-0.000290	392.4642	2.707E+11	0.000	0.000	0.000
57.120	0.0195	-98601.	21000.	-0.000291	383.0638	2.707E+11	0.000	0.000	0.000
59.160	0.0189	-55543.	21000.	-0.000291	373.6632	2.707E+11	0.000	0.000	0.000
61.200	0.0183	-12484.	21000.	-0.000292	364.2626	2.707E+11	0.000	0.000	0.000
63.240	0.0177	30575.	21000.	-0.000292	368.2124	2.707E+11	0.000	0.000	0.000
65.280	0.0171	73634.	21000.	-0.000291	377.6130	2.707E+11	0.000	0.000	0.000
67.320	0.0165	116693.	21000.	-0.000291	387.0135	2.707E+11	0.000	0.000	0.000
69.360	0.0159	159751.	21000.	-0.000290	396.4138	2.707E+11	0.000	0.000	0.000
71.400	0.0153	202807.	21000.	-0.000288	405.8140	2.707E+11	0.000	0.000	0.000
73.440	0.0147	245863.	21000.	-0.000286	415.2139	2.707E+11	0.000	0.000	0.000
75.480	0.0142	288918.	21000.	-0.000284	424.6135	2.707E+11	0.000	0.000	0.000
77.520	0.0136	331970.	21000.	-0.000282	434.0128	2.707E+11	0.000	0.000	0.000
79.560	0.0130	375021.	21000.	-0.000279	443.4116	2.707E+11	0.000	0.000	0.000
81.600	0.0124	418070.	21000.	-0.000276	452.8100	2.707E+11	0.000	0.000	0.000
83.640	0.0119	461116.	21000.	-0.000273	462.2078	2.707E+11	0.000	0.000	0.000
85.680	0.0113	504160.	21000.	-0.000270	471.6051	2.707E+11	0.000	0.000	0.000
87.720	0.0108	547201.	21000.	-0.000266	481.0018	2.707E+11	0.000	0.000	0.000
89.760	0.0102	590239.	21000.	-0.000261	490.3978	2.707E+11	0.000	0.000	0.000
91.800	0.009715	633273.	21000.	-0.000257	499.7931	2.707E+11	0.000	0.000	0.000
93.840	0.009196	676304.	21000.	-0.000252	509.1876	2.707E+11	0.000	0.000	0.000
95.880	0.008688	719331.	21000.	-0.000246	518.5812	2.707E+11	0.000	0.000	0.000
97.920	0.008191	762354.	21000.	-0.000241	527.9740	2.707E+11	0.000	0.000	0.000
99.960	0.007705	805373.	21000.	-0.000235	537.3658	2.707E+11	0.000	0.000	0.000
102.000	0.007232	848387.	20032.	-0.000229	546.7566	2.707E+11	-949.2737	267776.	0.000
104.040	0.006772	887446.	18101.	-0.000222	555.2839	2.707E+11	-943.5292	284241.	0.000
106.080	0.006325	922573.	16183.	-0.000215	562.9529	2.707E+11	-937.1399	302245.	0.000
108.120	0.005893	953795.	14278.	-0.000208	569.7693	2.707E+11	-930.0939	321979.	0.000
110.160	0.005475	981141.	12389.	-0.000201	575.7394	2.707E+11	-922.3790	343665.	0.000
112.200	0.005073	1004643.	10516.	-0.000194	580.8703	2.707E+11	-913.9817	367562.	0.000
114.240	0.004686	1024335.	8660.3636	-0.000186	585.1696	2.707E+11	-904.8878	393971.	0.000
116.280	0.004314	1040256.	6824.3948	-0.000178	588.6454	2.707E+11	-895.0816	423249.	0.000
118.320	0.003959	1052446.	5009.1743	-0.000170	591.3067	2.707E+11	-884.5463	455817.	0.000
120.360	0.003620	1060949.	3216.2085	-0.000162	593.1631	2.707E+11	-873.2633	492175.	0.000
122.400	0.003297	1065812.	1447.0439	-0.000154	594.2248	2.707E+11	-861.2119	532926.	0.000
124.440	0.002990	1067085.	-296.7287	-0.000146	594.5026	2.707E+11	-848.3691	578796.	0.000
126.480	0.002700	1064821.	-2013.4685	-0.000138	594.0084	2.707E+11	-834.7090	630667.	0.000
128.520	0.002426	1059077.	-3701.4777	-0.000130	592.7544	2.707E+11	-820.2020	689627.	0.000
130.560	0.002169	1049914.	-5358.9937	-0.000122	590.7540	2.707E+11	-804.8137	757024.	0.000
132.600	0.001927	1037396.	-6984.1781	-0.000114	588.0210	2.707E+11	-788.5043	834548.	0.000
134.640	0.001702	1021591.	-8575.1034	-0.000107	584.5704	2.707E+11	-771.2264	924351.	0.000
136.680	0.001492	1002570.	-10130.	-9.901E-05	580.4178	2.707E+11	-752.9227	1029205.	0.000
138.720	0.001298	980410.	-11646.	-9.154E-05	575.5798	2.707E+11	-733.5232	1152747.	0.000
140.760	0.001119	955192.	-13121.	-8.425E-05	570.0742	2.707E+11	-712.9403	1299843.	0.000
142.800	0.000954	927002.	-14553.	-7.715E-05	563.9197	2.707E+11	-691.0622	1477149.	0.000
144.840	0.000804	895930.	-15939.	-7.029E-05	557.1362	2.707E+11	-667.7424	1694032.	0.000
146.880	0.000668	862075.	-17241.	-6.366E-05	549.7449	2.707E+11	-608.2433	1858578.	0.000
148.920	0.000544	825683.	-18371.	-5.730E-05	541.7999	2.707E+11	-500.1669	1874353.	0.000
150.960	0.000434	787205.	-19292.	-5.123E-05	533.3994	2.707E+11	-401.9442	1890127.	0.000
153.000	0.000335	747050.	-20021.	-4.545E-05	524.6328	2.707E+11	-313.3169	1905902.	0.000

155.040	0.000248	705587.	-20579.	-3.997E-05	515.5806	2.707E+11	-233.9843	1921676.	0.000
157.080	0.000172	663146.	-21697.	-3.482E-05	506.3149	2.707E+11	-861.3359	10200000.	0.000
159.120	0.000106	617117.	-23118.	-2.999E-05	496.2658	2.707E+11	-531.6830	10200000.	0.000
161.160	4.989E-05	568872.	-23914.	-2.553E-05	485.7329	2.707E+11	-249.4606	10200000.	0.000
163.200	2.192E-06	519585.	-24180.	-2.142E-05	474.9727	2.707E+11	-10.9606	10200000.	0.000
165.240	-3.752E-05	470250.	-24000.	-1.770E-05	464.2019	2.707E+11	187.6050	10200000.	0.000
167.280	-7.001E-05	421693.	-23451.	-1.434E-05	453.6009	2.707E+11	350.0280	10200000.	0.000
169.320	-9.601E-05	374590.	-22605.	-1.134E-05	443.3174	2.707E+11	480.0405	10200000.	0.000
171.360	-0.000116	329482.	-21522.	-8.682E-06	433.4696	2.707E+11	581.2628	10200000.	0.000
173.400	-0.000131	286792.	-20259.	-6.361E-06	424.1495	2.707E+11	657.1616	10200000.	0.000
175.440	-0.000142	246835.	-18863.	-4.350E-06	415.4262	2.707E+11	711.0181	10200000.	0.000
177.480	-0.000149	209836.	-17377.	-2.630E-06	407.3485	2.707E+11	745.9032	10200000.	0.000
179.520	-0.000153	175940.	-15837.	-1.176E-06	399.9482	2.707E+11	764.6608	10200000.	0.000
181.560	-0.000154	145225.	-14271.	3.390E-08	393.2425	2.707E+11	769.8959	10200000.	0.000
183.600	-0.000153	117713.	-12707.	1.025E-06	387.2361	2.707E+11	763.9693	10200000.	0.000
185.640	-0.000150	93379.	-11164.	1.820E-06	381.9237	2.707E+11	748.9955	10200000.	0.000
187.680	-0.000145	72163.	-9658.2141	2.444E-06	377.2917	2.707E+11	726.8448	10200000.	0.000
189.720	-0.000140	53970.	-8203.7018	2.919E-06	373.3199	2.707E+11	699.1477	10200000.	0.000
191.760	-0.000133	38687.	-6809.9223	3.268E-06	369.9833	2.707E+11	667.3027	10200000.	0.000
193.800	-0.000126	26181.	-5484.1398	3.512E-06	367.2529	2.707E+11	632.4842	10200000.	0.000
195.840	-0.000119	16307.	-4231.4394	3.672E-06	365.0972	2.707E+11	595.6535	10200000.	0.000
197.880	-0.000112	8911.0128	-3055.1520	3.767E-06	363.4826	2.707E+11	557.5695	10200000.	0.000
199.920	-0.000104	3835.8400	-1957.2545	3.815E-06	362.3746	2.707E+11	518.8006	10200000.	0.000
201.960	-9.595E-05	919.6860	-938.7462	3.833E-06	361.7379	2.707E+11	479.7369	10200000.	0.000
204.000	-8.812E-05	0.000	0.000	3.837E-06	361.5372	2.707E+11	440.6025	5100000.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection             =      0.0306090 inches
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =      -1302216. inch-lbs
Maximum shear force              =        -24180. lbs
Depth of maximum bending moment  =       0.000000 inches below pile head
Depth of maximum shear force     =    163.2000000 inches below pile head
Number of iterations             =             10
Number of zero deflection points =              1
```

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-head Rotation radians
1	1	V = 15000.	M = 2760000.	581000.	0.22708058	4472894.	-104841.	-0.00291249
2	2	V = 21000.	S = 0.000	368000.	0.03060905	-1302216.	-24180.	0.00000000

The analysis ended normally.

Bridge 238 - Bent 1 - Boring B1-A

Required tip resistance

q_{req} = required tip resistance (rounded up to the nearest 10 ksf or 5 tsf)

$$= \frac{\frac{R_{req} - \varphi_{qs} R_{sd}}{A_T}}{\varphi_{tip}} \leq q_p$$

R_{req}		730	kips	Required factored geotechnical resistance
$\varphi_{qs,\ rock}$		0.55		side resistance factor, in Rock
$R_{sd,\ rock}$		0	kips	nominal side resistance, in Rock
$\varphi_{qs,\ IGM}$		0.6		side resistance factor, in IGM
$R_{sd,\ IGM}$		0	kips	nominal side resistance, in IGM
$\varphi_{qs} R_{sd}$		0	kips	factored developed side resistance
A_T		6.30	ft^2	Area of drilled pier tip (smaller than shaft diameter if rock sock
φ_{tip}		0.5		tip resistance factor
q_{req}		232	ksf	required tip resistance
	=	240	ksf	required tip resistance rounded to the nearest 10 ksf
	=	120	tsf	required tip resistance rounded in tsf
q_p		275	tsf	estimated nominal tip resistance

Required Resistance

R_{req} = required resistance

$$= P_r + y_{DL}(W_T - W_{Soil/Rock}) - y_{WA} W_{Water}$$

P_r		725	kips	Maximum factored axial load
y_{DL}		1.25		Factor for Permanent Dead loads from AASHTO Table 3.4.1-2
W_T		17	kips	Unfactored Weight of Drilled Pier and Column
	Pier Diameter	3	ft	
	Pier Length	13.5	ft	
	Column Diameter	2.5	ft	
	Column Length	3.5	ft	
	Weight of Concrete	0.155	$kips/ft^3$	
$W_{Soil/Rock}$		8	kips	Unfactored Weight of Soil/Rock that will be displaced below the Design Scour Elevation
	Pier Diameter	3	ft	
	Pier Length - Soil	0	ft	Pier Length in Soil Below the Design Scour Elevation
				DSE: 668 Bottom of Soil: 668
	Unit Weight - Soil	0.12	$kips/ft^3$	
	Pier Length - IGM	4.5	ft	Pier Length in IGM Below the Design Scour Elevation
				Top of IGM: 668 Bottom of IGM: 663.5
	Unit Weight - IGM	0.13	$kips/ft^3$	
	Pier Length - Rock	4	ft	Pier Length in Rock Below the Design Scour Elevation
				Top of Rock: 663.5 Bottom of Rock: 659.5
	Unit Weight - Rock	0.15	$kips/ft^3$	
y_{WA}		1		Factor for Water Loads from AASHTO Table 3.4.1-1
W_{water}		6	kips	Unfactored Weight of Water Displaced
	Unit Weight - Water	0.0624	$kips/ft^3$	

APPENDIX B-2 – BENT 1, BORING B1-B

BORING B1-B WITH RELEVANT ELEVATIONS
AXIAL CALCULATIONS
L-PILE ANALYSES
REQUIRED TIP RESISTANCE CALCULATIONS

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B1-B	**STATION** 12+18	**OFFSET** 13 ft RT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 683.0 ft	**TOTAL DEPTH** 41.1 ft	**NORTHING** 829,388	**EASTING** 1,782,568	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/08/12	**COMP. DATE** 06/08/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	ELEV. (ft)	DEPTH (ft)
685												
										GROUND SURFACE	683.0	0.0
680	679.5	3.5	WOH	2	4	6		M		**ROADWAY EMBANKMENT** Brown, sandy CLAY		
675	674.5	8.5	WOH	WOH	2	2		M				
670	669.5	13.5	3	6	4	10		W		**ALLUVIAL** Gray and tan, clayey SAND, trace roots	671.0	12.0
665	664.5	18.5	100/0.2			100/0.2				**WEATHERED ROCK** (White and green Metamorphosed Granite)	667.0	16.0
	663.5	19.5	60/0.1			60/0.1				**CRYSTALLINE ROCK** Gray and white with green Metamorphosed Granite	663.4	19.6
660												
655												
650												
645											641.9	41.1

B.O.C. ~ 676.5

T.O.S. ~ 673

Scour ~ 667

P.O.F. ~ 660.5

TIP ~ 658.9

Boring Terminated at Elevation 641.9 ft in Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-7/8" tricone carb. bit to 19.5 feet.
2) Advanced NW casing 10 19.5 feet.
3) Advanced NQ2 core barrel from 19.5 feet to 41.1 feet.
4) Used creek water and bentonite as drilling fluid.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/8/12

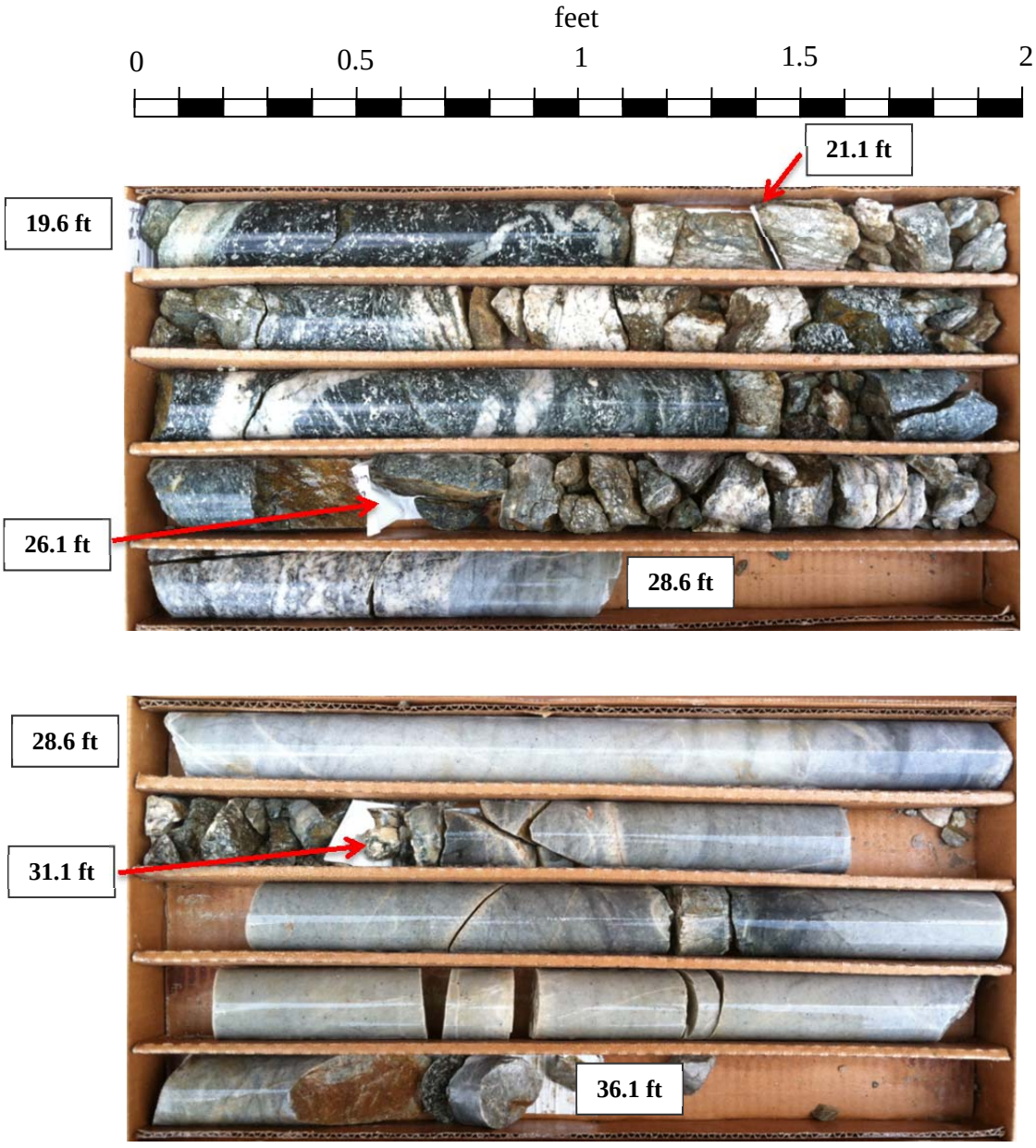
NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			**GROUND WTR (ft)**
BORING NO. B1-B	**STATION** 12+18	**OFFSET** 13 ft RT	**ALIGNMENT** L — **0 HR.** N/A
COLLAR ELEV. 683.0 ft	**TOTAL DEPTH** 41.1 ft	**NORTHING** 829,388	**EASTING** 1,782,568 — **24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/08/12	**COMP. DATE** 06/08/12	**SURFACE WATER DEPTH** N/A
CORE SIZE NQ2	**TOTAL RUN** 21.5 ft		

ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS
663.4											Begin Coring @ 19.6 ft
	663.4	19.6									ELEV. (ft) DEPTH (ft)
	661.9	21.1	1.5	5:01/1.0 2:34/0.5	(1.5) 100%	(0.6) 42%		(20.4) 95%	(10.4) 48%		**CRYSTALLINE ROCK** 19.6 Gray and white with green, fresh to moderately severe weathering, medium hard to hard, METAMORPHOSED GRANITE, with moderately close to very close fracture spacing.
660			5.0	4:58/1.0 4:37/1.0 4:17/1.0 6:26/1.0 6:24/1.0	(4.8) 96%	(1.3) 26%					TIP ~ 658.9
	656.9	26.1									
655			5.0	5:06/1.0 3:40/1.0 5:31/1.0 6:02/1.0 7:52/1.0	(4.8) 96%	(2.3) 46%					
	651.9	31.1									
650			5.0	4:50/1.0 4:11/1.0 4:42/1.0 4:04/1.0 4:39/1.0	(4.8) 96%	(2.9) 58%					
	646.9	36.1									
645			5.0	5:21/1.0 3:49/1.0 3:05/1.0 5:02/1.0 3:38/1.0	(4.5) 90%	(3.3) 66%					
	641.9	41.1									641.9 41.1 Boring Terminated at Elevation 641.9 ft in Crystalline Rock (Metamorphosed Granite) 1) Advanced 3-7/8" tricone carb. bit to 19.5 feet. 2) Advanced NW casing 10 19.5 feet. 3) Advanced NQ2 core barrel from 19.5 feet to 41.1 feet. 4) Used creek water and bentonite as drilling fluid.

North Carolina Department of Transportation
Geotechnical Unit
Rock Core Photo

T.I.P. No..: 17BP.7.R.37	*Bridge No.*: 400238	*County*: Guilford	*Boring Location:* **B1-B**
Site Description: Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			
Driller: W. Duggins	*Core Size*: NQ2	*Drill Machine:* Diedrich D-50	
Geologist / Engineer: T. Bartlett	*Total Run Length:* 21.5 feet	*Date:* 6/08/2012	



Notes:
1) Used NQ2 core barrel with wire line

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Charlotte, North Carolina 28206
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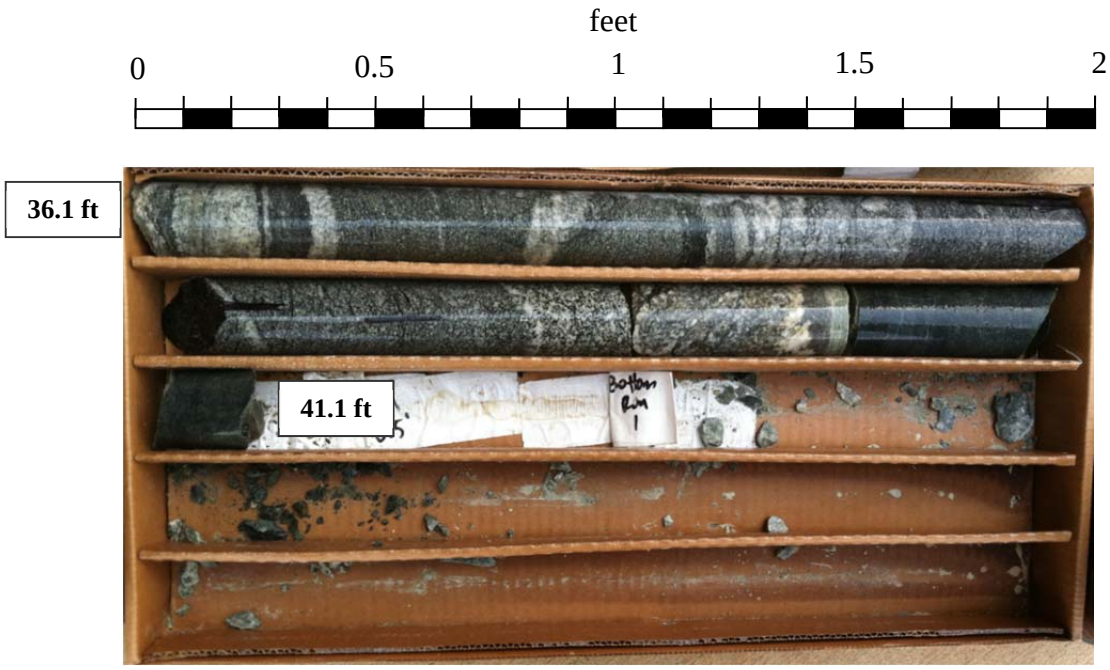
North Carolina Department of Transportation
Geotechnical Unit
Rock Core Photo

T.I.P. No..: 17BP.7.R.37	*Bridge No.*: 400238	*County*: Guilford	*Boring Location:* **B1-B**
Site Description: Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			
Driller: W. Duggins	*Core Size*: NQ2	*Drill Machine:* Diedrich D-50	
Geologist / Engineer: T. Bartlett	*Total Run Length:* 21.5 feet	*Date:* 6/08/2012	



Notes:
1) Used NQ2 core barrel with wire line

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Terracon

Analysis Performed By:	*JPM*
Date of Analysis:	*11/8/2012*
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT TIP RESISTANCE IN SOIL, IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1B*	
Boring Elevation:	*673.00*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	*ft*
Shaft Length:	*14*	*ft (below grade)*	**Tip Elevation:**	*659.00*	*ft MSL*	**Cross-section Area:**	*7.1*	*ft²*
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	*ft*

Type of Material at the Tip:	**Rock**

f_c': concrete compressive strength =	**4.50**	ksi

For Soil Section 10.8.3.5.2c, *2010 AASHTO LRFD Bridge Design Specifications*

Cohesionless Soils: $N_{60} \le 50$, $q_p = 1.2*N_{60}$ Equation 10.8.3.5.2c-1, *2010 AASHTO LRFD Bridge Design Specifications*

Cohesive Soils: $N_c = 6(1+0.2(Z/D)) \le 9$ $q_p = N_c * S_u \le 80$ where Z= penetration of shaft in bearing layer

S_u = ksf

Z = ft

N_c =

Cohesionless Soils: **Unit Tip Resistance in Soil, q_p =** (q_p is limited to a maximum of 60 ksf)

Cohesive Soils: **Unit Tip Resistance in Soil, q_p =** (q_p is limited to a maximum of 80 ksf)

For IGM (IGM: Cohesionless soils with blow counts greater than 50 blows/ft, i.e., Very Dense/Hard Soils and PWR)
Section 10.8.3.5.2c, *2010 AASHTO LRFD Bridge Design Specifications*

$$q_p = 0.59 \left[N_{60} \left\{ \frac{p_a}{\sigma'_v} \right\} \right]^{0.8} \sigma'_v$$

Equation 10.8.3.5.2c-2, *2010 AASHTO LRFD Bridge Design Specifications*

Material unit weight at tip =	0.14	kcf		Depth of the tip:	14	ft	Water Level (ft):	0 ft
N: Uncorrected SPT Blow Count at the Tip =	1000	blows/ft		N_{60}* = (ER/60%)N =	100	blows/ft	Type of Hammer:	auto
p_a: atmospheric pressure =	2.12	ksf		σ'_v : vertical effective stress at tip =	0.87	ksf	ER: Hammer Efficiency:	80%

*N_{60} is limited to a maximum of 100 bpf

Unit Tip Resistance in IGM, q_p =

For Rock

$q_p = A + q_u [m_b (A/q_u) + s]^a$ where $A = \sigma'_v + q_u [m_b (\sigma'_v/q_u) + s]^a$

Reference: Turner (2006). *NCHRP Synthesis 360 Rock-Socketed Shafts for Highways Structure Foundations* . Transportation Research Board of National Academies. 136 pp.

q_u: unconfined compressive strength of intact rock — s, a : constant for the Rock Mass — GSI: Geological Strength Index — $GSI^* \approx 18.7e^{(0.0152RQD)}$

m_b: Reduced Value of m_i — $s = \exp^{((GSI-100)/9)}$ — $m_b = m_i (\exp^{((GSI-100)/28)})$ — $a = 1/2 + 1/6(e^{-GSI/15} - e^{-20/3})$ — RQD: Rock Quality Designation

q_u =	1,152	ksf	m_i =	29		RQD =	48	%	A =	65.17	ksf
GSI =	39	s =	1.11E-03	a =	0.51	m_b =	3.26				

* Correlation defined by Truzman et. al. (2011) "Determination of Unit Tip Resistance for Drilled Shafts in Fractured Rocks using the Global Rock Mass Strength", 2011 Pan-Am CGS Geotechnical Conference

Unit Tip Resistance in Rock, q_p = 551 ksf in Rock < fc' = 648 ksf

NOTE: Please input the required data where indicated in Blue. When calculating Tip Resistance in Cohesive Soil, please input an Undrained Shear Strength value, Su, into the "Side in Soils (using a-method)" sheet for the bearing layer to generate a tip resistance in cohesive soils output on this sheet. When calculating Tip Resistance in IGM, no data needs to be input onto this sheet other than indicating IGM or Rock as the material at the tip, and the Project Information at the top of the sheet. Please input all soil strata data and shaft information into the "Side in Soils (using B-method)" sheet to generate a tip resistance in IGM output on this sheet. You should always check the input and output values on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/8/2012***
Analysis Reviewed By:	

DRILLED SHAFT SIDE RESISTANCE CALCULATION USING β-METHOD

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*14*	*ft (below grade)*	**Tip Elevation:**	*659*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*			

UNIT SIDE RESISTANCE (q_s) (*Section 10.8.3.5.2b, 2010 AASHTO LRFD Bridge Design Specifications*)

$q_s = \beta\sigma_v'$ ≤ 4.0 ksf for 0.25 ≤ β ≤ 1.2 (Eq. 10.8.3.5.2b-1)

For N_{60} ≤ 15	$\beta = (1.5 - 0.135\,(z)^{0.5})\,N_{60}/15$		
For N_{60} ≥ 15	$\beta = 1.5 - 0.135\,(z)^{0.5}$ (sandy soils)	or	$\beta = 2.0 - 0.06\,(z)^{0.75}$ (gravelly sands and gravels)
N_{60} = (ER/60%)N	N_{60}: SPT blow count corrected for hammer efficiency (blows/ft)		N: uncorrected SPT blow count
σ'_v = vertical effective stress	Hammer efficiency = 80%	Type of Hammer: auto	Water Level (ft): 0 ft

# of Layers:	3	Layer the Tip is located in:	3

Layer	USCS	Soil Type	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	β	Check if 0.25<β<1.2	q_s (ksf)	Check if $q_s \le 4.0$ ksf	Q_{si} (kips)
1	CL	Clay	0	6	0.110	3.0	0.143	0	0					
2	PWR	IGM	6	9.5	0.130	7.8	0.404	100	133	1.12	1.12	IGM Mat'l		
3	Rock	Rock	9.5	31	0.140	11.8	0.697	1000				Rock		

Total Skin Friction in Soils, $\Sigma(Q_{s,soils})_i$ = 0

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/8/2012***
Analysis Reviewed By:	

DRILLED SHAFT SIDE RESISTANCE CALCULATION USING α-METHOD

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*14*	*ft (below grade)*	**Tip Elevation:**	*659*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*			

UNIT SIDE RESISTANCE (q_s) (*Section 10.8.3.5.1b, 2010 AASHTO LRFD Bridge Design Specifications*)

$q_s = \alpha S_u$ (Eq. 10.8.3.5.1b-1)

For $S_u/p_a \leq 1.5$	$\alpha = 0.55$			
For $1.5 \leq S_u/p_a \leq 2.5$	$\alpha = 0.55 - 0.1(S_u/p_a - 1.5)$	Su = undrained shear strength (ksf)	α = adhesion factor	p_a = atm. pressure = 2.12 ksf
N_{60} = (ER/60%)N	N_{60}: SPT blow count corrected for hammer efficiency (blows/ft)		N: uncorrected SPT blow count	
σ'_v = vertical effective stress	Hammer efficiency = 80%	Type of Hammer: auto	Water Level (ft): 0 ft	

# of Layers:	3	Layer the Tip is located in:	3											
Layer	USCS	Soil Type	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	S_u (ksf)	S_u/p_a	α	q_s (ksf)	Q_{si} (kips)
1	CL	Clay	0	6	0.110	3.0	0.143	0	0	0.00	0.00	0.55	0.00	0
2	PWR	IGM	6	9.5	0.130	7.8	0.404	100	133	0.00	0.00	IGM Mat'l		
3	Rock	Rock	9.5	31	0.140	11.8	0.697	1000				Rock		

Total Skin Friction in Soils, $\Sigma(Q_{s,soils})_i$ = 0

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Analysis Performed By:	***JPM***
Date of Analysis:	***11/8/2012***
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR WEAK ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*14*	*ft (below grade)*	**Tip Elevation:**	*659*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	ft

UNIT SIDE RESISTANCE (q_s) for COHESIONLESS IGM SOILS (*Section 10.8.3.5.5, 2010 AASHTO LRFD Bridge Design Specifications*)

$$q_s = \sigma'_v K_o \tan \Phi'$$

Equation referenced from Chapter 11, *Drilled Shafts: Construction Procedures and Design Methods*, FHWA Publication No. FHWA-IF-99-025, O'Neill and Reese, August, 1999.

IGM: Very Hard/Very Dense Cohesionless Soils and PWR with SPT N_{60} > 50 blows-per-foot		N_{60} = (ER/60%)N = SPT N-value corrected for Hammer Efficiency
$\Phi' = \tan^{-1}((N_{60}/(12.3+20.3(\sigma'_v/p_a)))^{0.34}$	Φ' = effective stress friction angle of IGM	N: Uncorrected SPT N-Value along the shaft
$K_o = (1-\sin\Phi')OCR^{\sin\Phi'}$	K_o = in-situ coefficient of lateral earth pressure	Hammer Efficiency, ER = 80%
$OCR = \sigma'_p/\sigma'_v$	σ'_v = vertical effective stress	Type of hammer = auto
$\sigma'_p = 0.2N_{60}p_a$	σ'_p = vertical effective stress	Atmospheric Pressure, p_a = 2.12 ksf

# of Layers: 3

Layer	Material	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	ϕ' (degrees)	σ'_p (ksf)	OCR	K_o	q_s ** (ksf)	Q_s (kips)
1	CL	0	6	0.110	3.0	0.143	0	0				Not IGM		
2	PWR	6	9.5	0.130	7.8	0.404	100	133	61.7	42.400	104.98	7.19	2.7	89
3	Rock	9.5	31	0.140	11.8	0.697	1000					Not IGM		

***Unit Side Resistance, qs, has been reduced by 50% of its calculated value based on past local experience in IGM Materials.**

Total Skin Friction in IGM, $\Sigma(Q_{s,IGM})_i$ = 89

NOTE: No data needs to be input on this sheet to calculate skin resistance in IGM. Please input all soil strata information into the "Side in Soils" sheet to generate a skin resistance in IGM output on this sheet. You should always check the input and output information on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	*JPM*
Date of Analysis:	*11/8/2012*
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*14*	*ft (below grade)*	**Tip Elevation:**	*659*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	ft

UNIT SIDE RESISTANCE (q_s) for DRILLED SHAFTS in ROCK (*Section 10.8.3.5.4b, 2010 AASHTO LRFD Bridge Design Specifications*)

$$q_s = 0.65\,\alpha_E\,p_a\,(q_u/p_a)^{0.5} < 7.8\,p_a\,(f_c'/p_a)^{0.5}$$ (Equation 10.8.3.5.4b-1)

For Rock Layer 1

p_a: atmospheric pressure =		2.12	ksf	f_c': concrete compressive strength =		4.50	ksi
q_u: unconfined compressive strength of rock =		1152	ksf	E_m/E_i: reduction factor (determined from Table 10.4.6.5-1) =		0.07	
RQD =	30 %	GSI =	28	α_E = reduction factor to account for jointing in rock =		0.48	

q_s = 15.53 ksf ≤ 24.09 ksf

calculation of qs is OK **use qs = 15.53 ksf for Rock Layer 1**

For Rock Layer 2

p_a: atmospheric pressure =		2.12	ksf	f_c': concrete compressive strength =		4.50	ksi
q_u: unconfined compressive strength of rock =			ksf	E_m/E_i: reduction factor (determined from Table 10.4.6.5-1) =		0.05	
RQD =	%	GSI =		α_E = reduction factor to account for jointing in rock =		0.45	

q_s = 0.00 ksf ≤ 24.09 ksf

calculation of qs is OK **use qs = 0.00 ksf for Rock Layer 2**

AREA OF SHAFT SIDE SURFACE (As) in ROCK

Length in Layer 1 =	4.5	ft
Length in Layer 2 =		ft
Socket Diameter =	2.8333	ft
Socket perimeter =	8.90	ft

A_s = 40.05 ft^2

Total Skin Friction in Rock, $Q_{s,rock}$ = 622 kips

NOTE: When calculating side resistance in Rock on this sheet, please input the required input data where indicated in Blue. Please input all rock/soil data and shaft information correctly into the "Tip" sheet to generate a Skin Resistance in Rock output on this sheet. You should always check the input and output values on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/8/2012***
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 1, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B1B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*14*	*ft (below grade)*	**Tip Elevation:**	*659*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	0.0	ft

Table 10.5.5.2.4-1 Resistance Factors for Geotechnical resistance of Drilled Shafts (2010 AASHTO LRFD Bridge Design Specifications)

Method/Soil/Condition			Resistance Factor
Nominal Axial Compressive Resistance of Single-Drilled Shafts, φ_{stat}	Side resistance in clay	α-method (O'Neill and Reese, 1999)	0.45
	Tip resistance in clay	Total Stress (O'Neill and Reese, 1999)	0.40
	Side resistance in sand	β-method (O'Neill and Reese, 1999)	0.55
	Tip resistance in sand	O'Neill and Reese (1999)	0.50
	Side resistance in IGMs	O'Neill and Reese (1999)	0.60
	Tip resistance in IGMs	O'Neill and Reese (1999)	0.55
	Side resistance in rock	Horvath and Kenney (1979)	0.5
	Tip resistance in rock	O'Neill and Reese (1999)	0.50
Static Load Test (compression), φ_{load}	All Materials		Values in Table 10.5.5.2.3-2, but no greater than 0.70

Nominal Shaft Tip Resistance (R_p)

$R_p = q_p \times A_p$ (Equation 10.8.3.5-2)

q_p = 551 ksf A_p = 6.30 ft^2 **R_p = 3,475 kips** ***(In Rock)***

Nominal Shaft Side Resistance (R_s)

$R_s = q_s \times A_s$ (Equation 10.8.3.5-3)

$R_{s,clay}$ = 0 kips **$R_{s,sand}$ = 0 kips** **$R_{s,IGM}$ = 89 kips** **$R_{s,rock}$ = 622 kips**

Total Nominal Resistance ($R_p + R_s$) = 4,186 kips equivalent to **18,619 kN**

REDUCTION DUE TO GROUP EFFECTS

0.65 ≤ η ≤ 1.00 for 2.5*dia. ≤ Distance Between Shafts ≤ 6*dia. (Section 10.8.3.6.3)

Distance Between Shafts = 18 **feet** **η = 1.00**

FACTORED RESISTANCE OF SINGLE DRILLED SHAFT

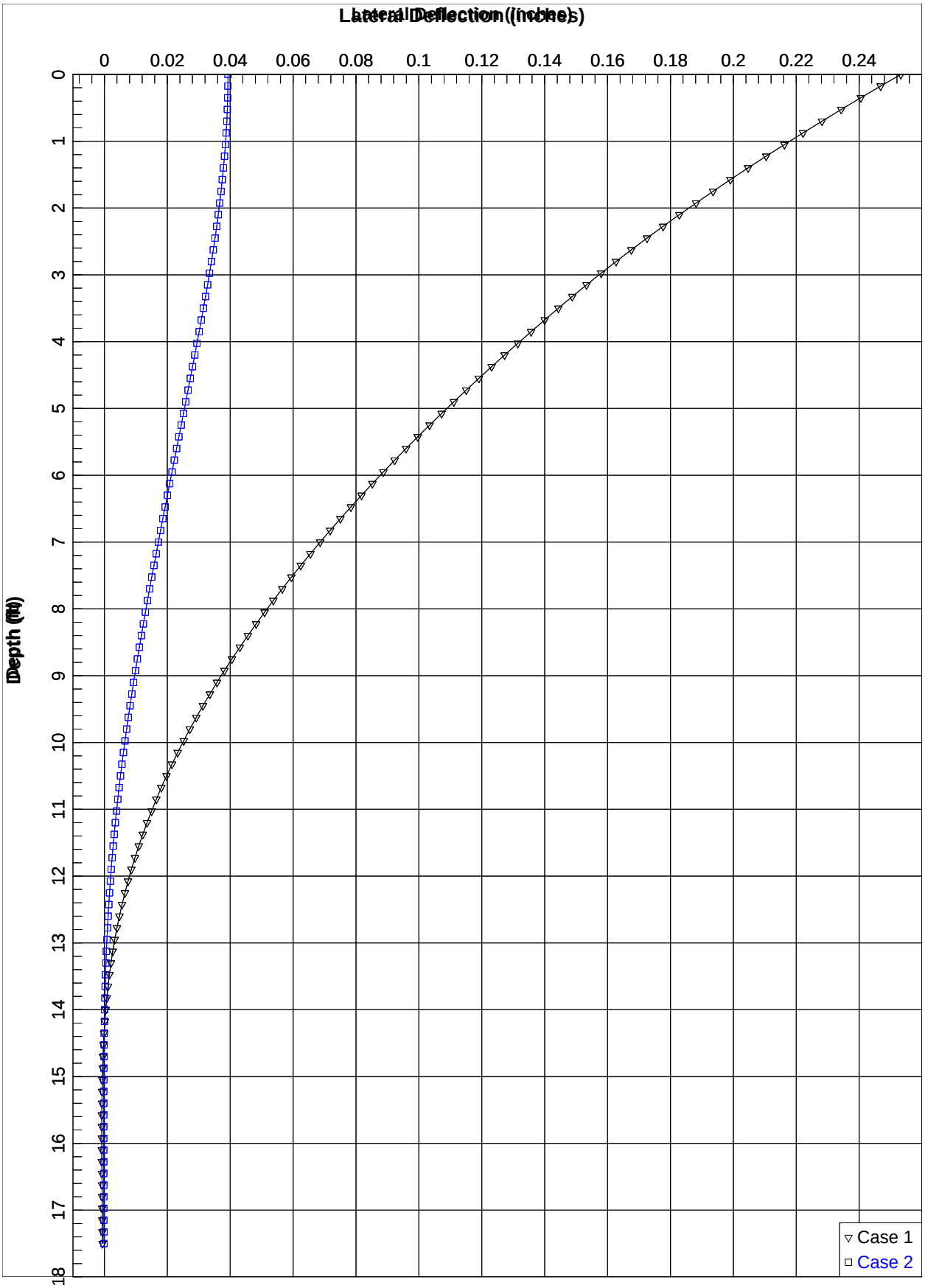
$R_R = \varphi R_n = \varphi_{qp} R_p + \varphi_{qs} R_s$ (Equation 10.8.3.5-1)

φ_{qp} = resistance factor for tip resistance specified in Table 10.5.5.2.4-1

φ_{qs} = resistance factor for shaft side resistance specified in Table 10.5.5.2.4-1

φ_{qp} =	0.50	Rock									
φ_{qs} =	0.45	Clay	φ_{qs} =	0.55	Sand	φ_{qs} =	0.60	IGM	φ_{qs} =	0.55	Rock

Total Factored Resistance, R_R = 2,133 kips


Lateral Deflection (inches)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Case 1
Case 2

LPile Plus for Windows, Version 6 (6.0.28)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Serial Number of Security Device: 156316250
Company Name Stored in Security Device: WPC, Inc.

Files Used for Analysis

Path to file locations: N:\Projects\2011\71115060\Working Files\Bridge 238\Calculations-Analyses\
Name of input data file: Bridge 238 - B1B.lp6d
Name of output report file: Bridge 238 - B1B.lp6o
Name of plot output file: Bridge 238 - B1B.lp6p
Name of runtime messeage file: Bridge 238 - B1B.lp6r

Date and Time of Analysis

Date: November 8, 2012 Time: 8:55:11

Problem Title

Low Impact Bridge - Guilford County No. 238

71115060

KHA

Terracon

Boring B1B - Bent 1

Program Options

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes pile response to lateral loading and will compute nonlinear moment-curvature and nominal moment capacity for selected section types.

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total Number of Sections	=	2	
Total Pile Length	=	17.50	ft
Depth of ground surface below top of pile	=	9.50	ft

Pile dimensions used for p-y curve computations defined using 4 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	30.0000000
2	3.500000	30.0000000

3	3.500000	36.0000000
4	17.500000	36.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	3.500 ft
Top Width	=	30.000 in
Bottom Width	=	30.000 in
Top Area	=	706.858347 sq. in
Bottom Area	=	706.858347 sq. in
Moment of Inertia at Top	=	39760.782 in^4
Moment of Inertia at Bottom	=	39760.782 in^4
Elastic Modulus	=	3283676. lbs/in^2

Pile Section No. 2:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	14.000 ft
Top Width	=	36.000 in
Bottom Width	=	36.000 in
Top Area	=	1017.876020 sq. in
Bottom Area	=	1017.876020 sq. in
Moment of Inertia at Top	=	82447.958 in^4
Moment of Inertia at Bottom	=	82447.958 in^4
Elastic Modulus	=	3283676. lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer = 9.500 ft
Distance from top of pile to bottom of layer = 13.000 ft

Layer 2 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 13.000 ft
Distance from top of pile to bottom of layer = 34.500 ft

(Depth of lowest layer extends 17.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	9.50	70.00000
2	13.00	70.00000
3	13.00	80.00000
4	34.50	80.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	J	kpy pci	Rock Emass psi	Depth ft	Eff. Unit Wt., pcf	Cohesion krm	Friction Test Type	Test Prop. Ang., deg.	Elas. Subgr. pci	qu psi	RQD percent	Epsilon 50
1	Stiff Clay w/o Free Water	--	--	--	9.500	70.000	4000.000	--	--	--	--	--	5.00E-04
					13.000	70.000	4000.000	--	--	--	--	--	5.00E-04
2	Vuggy Limestone	--	--	--	13.000	80.000	--	--	--	--	5000.000	--	--
					34.500	80.000	--	--	--	--	5000.000	--	--

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 15000. lbs	M = 2760000. in-lbs	581000.
2	2	V = 21400. lbs	S = 0.0000 in/in	368000.

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Moment-Curvature properties derived from elastic section properties

Pile Section No. 2:

Moment-Curvature properties derived from elastic section properties

---

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Horizontal shear force at pile head = 15000.000 lbs
Applied moment at pile head = 2760000.000 in-lbs
Axial thrust load on pile head = 581000.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2533	2760000.	15000.	-0.003074	1863.1739	1.306E+11	0.000	0.000	0.000
2.100	0.2469	2795224.	15000.	-0.003030	1876.4623	1.306E+11	0.000	0.000	0.000
4.200	0.2405	2830393.	15000.	-0.002984	1889.7300	1.306E+11	0.000	0.000	0.000
6.300	0.2343	2865506.	15000.	-0.002939	1902.9768	1.306E+11	0.000	0.000	0.000
8.400	0.2282	2900564.	15000.	-0.002892	1916.2024	1.306E+11	0.000	0.000	0.000
10.500	0.2222	2935564.	15000.	-0.002845	1929.4065	1.306E+11	0.000	0.000	0.000
12.600	0.2162	2970507.	15000.	-0.002798	1942.5888	1.306E+11	0.000	0.000	0.000
14.700	0.2104	3005391.	15000.	-0.002750	1955.7492	1.306E+11	0.000	0.000	0.000
16.800	0.2047	3040217.	15000.	-0.002701	1968.8873	1.306E+11	0.000	0.000	0.000
18.900	0.1991	3074982.	15000.	-0.002652	1982.0029	1.306E+11	0.000	0.000	0.000
21.000	0.1936	3109688.	15000.	-0.002602	1995.0958	1.306E+11	0.000	0.000	0.000
23.100	0.1881	3144332.	15000.	-0.002552	2008.1656	1.306E+11	0.000	0.000	0.000
25.200	0.1828	3178915.	15000.	-0.002501	2021.2122	1.306E+11	0.000	0.000	0.000
27.300	0.1776	3213435.	15000.	-0.002450	2034.2352	1.306E+11	0.000	0.000	0.000
29.400	0.1726	3247893.	15000.	-0.002398	2047.2344	1.306E+11	0.000	0.000	0.000
31.500	0.1676	3282286.	15000.	-0.002345	2060.2096	1.306E+11	0.000	0.000	0.000
33.600	0.1627	3316615.	15000.	-0.002292	2073.1604	1.306E+11	0.000	0.000	0.000
35.700	0.1579	3350879.	15000.	-0.002238	2086.0867	1.306E+11	0.000	0.000	0.000
37.800	0.1533	3385078.	15000.	-0.002184	2098.9883	1.306E+11	0.000	0.000	0.000
39.900	0.1488	3419209.	15000.	-0.002130	2111.8647	1.306E+11	0.000	0.000	0.000
42.000	0.1444	3453274.	15000.	-0.002089	1324.7137	2.707E+11	0.000	0.000	0.000
44.100	0.1400	3487306.	15000.	-0.002062	1332.1435	2.707E+11	0.000	0.000	0.000
46.200	0.1357	3521305.	15000.	-0.002035	1339.5662	2.707E+11	0.000	0.000	0.000
48.300	0.1315	3555271.	15000.	-0.002007	1346.9816	2.707E+11	0.000	0.000	0.000
50.400	0.1273	3589203.	15000.	-0.001979	1354.3896	2.707E+11	0.000	0.000	0.000
52.500	0.1231	3623101.	15000.	-0.001951	1361.7902	2.707E+11	0.000	0.000	0.000
54.600	0.1191	3656965.	15000.	-0.001923	1369.1834	2.707E+11	0.000	0.000	0.000
56.700	0.1151	3690794.	15000.	-0.001895	1376.5689	2.707E+11	0.000	0.000	0.000
58.800	0.1111	3724589.	15000.	-0.001866	1383.9469	2.707E+11	0.000	0.000	0.000
60.900	0.1072	3758348.	15000.	-0.001837	1391.3172	2.707E+11	0.000	0.000	0.000
63.000	0.1034	3792071.	15000.	-0.001808	1398.6796	2.707E+11	0.000	0.000	0.000
65.100	0.0996	3825759.	15000.	-0.001778	1406.0343	2.707E+11	0.000	0.000	0.000
67.200	0.0959	3859410.	15000.	-0.001748	1413.3811	2.707E+11	0.000	0.000	0.000
69.300	0.0923	3893025.	15000.	-0.001718	1420.7198	2.707E+11	0.000	0.000	0.000
71.400	0.0887	3926603.	15000.	-0.001688	1428.0506	2.707E+11	0.000	0.000	0.000
73.500	0.0852	3960144.	15000.	-0.001657	1435.3732	2.707E+11	0.000	0.000	0.000
75.600	0.0818	3993647.	15000.	-0.001626	1442.6876	2.707E+11	0.000	0.000	0.000
77.700	0.0784	4027113.	15000.	-0.001595	1449.9938	2.707E+11	0.000	0.000	0.000
79.800	0.0751	4060540.	15000.	-0.001564	1457.2917	2.707E+11	0.000	0.000	0.000
81.900	0.0718	4093929.	15000.	-0.001532	1464.5812	2.707E+11	0.000	0.000	0.000
84.000	0.0686	4127279.	15000.	-0.001500	1471.8622	2.707E+11	0.000	0.000	0.000
86.100	0.0655	4160591.	15000.	-0.001468	1479.1347	2.707E+11	0.000	0.000	0.000
88.200	0.0624	4193863.	15000.	-0.001436	1486.3986	2.707E+11	0.000	0.000	0.000
90.300	0.0595	4227095.	15000.	-0.001403	1493.6538	2.707E+11	0.000	0.000	0.000
92.400	0.0566	4260287.	15000.	-0.001370	1500.9003	2.707E+11	0.000	0.000	0.000
94.500	0.0537	4293439.	15000.	-0.001337	1508.1380	2.707E+11	0.000	0.000	0.000
96.600	0.0509	4326550.	15000.	-0.001304	1515.3668	2.707E+11	0.000	0.000	0.000
98.700	0.0482	4359620.	15000.	-0.001270	1522.5867	2.707E+11	0.000	0.000	0.000
100.800	0.0456	4392649.	15000.	-0.001236	1529.7976	2.707E+11	0.000	0.000	0.000
102.900	0.0430	4425637.	15000.	-0.001202	1536.9994	2.707E+11	0.000	0.000	0.000
105.000	0.0406	4458582.	15000.	-0.001167	1544.1920	2.707E+11	0.000	0.000	0.000

107.100	0.0381	4491485.	15000.	-0.001133	1551.3755	2.707E+11	0.000	0.000	0.000
109.200	0.0358	4524346.	15000.	-0.001098	1558.5496	2.707E+11	0.000	0.000	0.000
111.300	0.0335	4557164.	15000.	-0.001063	1565.7144	2.707E+11	0.000	0.000	0.000
113.400	0.0313	4589939.	15000.	-0.001027	1572.8698	2.707E+11	0.000	0.000	0.000
115.500	0.0292	4622671.	13575.	-0.000991	1580.0157	2.707E+11	-1356.7763	97520.	0.000
117.600	0.0272	4649375.	10737.	-0.000955	1585.8458	2.707E+11	-1346.5987	104070.	0.000
119.700	0.0252	4670097.	7920.6815	-0.000919	1590.3698	2.707E+11	-1335.4581	111270.	0.000
121.800	0.0233	4684885.	5128.9623	-0.000883	1593.5984	2.707E+11	-1323.3221	119209.	0.000
123.900	0.0215	4693793.	2363.8110	-0.000847	1595.5432	2.707E+11	-1310.1553	127995.	0.000
126.000	0.0198	4696879.	-372.5667	-0.000810	1596.2169	2.707E+11	-1295.9187	137752.	0.000
128.100	0.0181	4694205.	-3077.8794	-0.000774	1595.6332	2.707E+11	-1280.5696	148633.	0.000
130.200	0.0165	4685840.	-5749.7408	-0.000737	1593.8068	2.707E+11	-1264.0603	160820.	0.000
132.300	0.0150	4671856.	-8385.6587	-0.000701	1590.7538	2.707E+11	-1246.3378	174536.	0.000
134.400	0.0136	4652331.	-10983.	-0.000665	1586.4912	2.707E+11	-1227.3424	190053.	0.000
136.500	0.0122	4627350.	-13539.	-0.000629	1581.0373	2.707E+11	-1207.0069	207711.	0.000
138.600	0.0109	4597002.	-16051.	-0.000593	1574.4117	2.707E+11	-1185.2543	227933.	0.000
140.700	0.009712	4561383.	-18516.	-0.000558	1566.6355	2.707E+11	-1161.9963	251261.	0.000
142.800	0.008578	4520597.	-20930.	-0.000522	1557.7311	2.707E+11	-1137.1299	278387.	0.000
144.900	0.007518	4474753.	-23290.	-0.000488	1547.7225	2.707E+11	-1110.5345	310221.	0.000
147.000	0.006530	4423970.	-25592.	-0.000453	1536.6355	2.707E+11	-1082.0662	347972.	0.000
149.100	0.005615	4368373.	-27832.	-0.000419	1524.4975	2.707E+11	-1051.5508	393284.	0.000
151.200	0.004771	4308097.	-30006.	-0.000385	1511.3381	2.707E+11	-1018.7740	448447.	0.000
153.300	0.003997	4243287.	-32108.	-0.000352	1497.1889	2.707E+11	-983.4662	516739.	0.000
155.400	0.003292	4174101.	-34134.	-0.000319	1482.0841	2.707E+11	-945.2792	603024.	0.000
157.500	0.002655	4100706.	-49065.	-0.000287	1466.0606	2.707E+11	-13275.	10500000.	0.000
159.600	0.002085	3968729.	-73950.	-0.000256	1437.2475	2.707E+11	-10425.	10500000.	0.000
161.700	0.001579	3790742.	-93188.	-0.000226	1398.3895	2.707E+11	-7897.4802	10500000.	0.000
163.800	0.001136	3577891.	-107443.	-0.000197	1351.9200	2.707E+11	-5679.0549	10500000.	0.000
165.900	0.000750	3339962.	-117346.	-0.000171	1299.9754	2.707E+11	-3752.0336	10500000.	0.000
168.000	0.000419	3085455.	-123487.	-0.000146	1244.4115	2.707E+11	-2097.0380	10500000.	0.000
170.100	0.000139	2821671.	-126417.	-0.000123	1186.8222	2.707E+11	-693.3396	10500000.	0.000
172.200	-9.611E-05	2554802.	-126641.	-0.000102	1128.5596	2.707E+11	480.5458	10500000.	0.000
174.300	-0.000289	2290028.	-124617.	-8.310E-05	1070.7543	2.707E+11	1446.3534	10500000.	0.000
176.400	-0.000445	2031611.	-120762.	-6.634E-05	1014.3369	2.707E+11	2225.6480	10500000.	0.000
178.500	-0.000568	1782990.	-115443.	-5.154E-05	960.0580	2.707E+11	2839.4764	10500000.	0.000
180.600	-0.000662	1546874.	-108989.	-3.863E-05	908.5093	2.707E+11	3308.0880	10500000.	0.000
182.700	-0.000730	1325333.	-101682.	-2.749E-05	860.1424	2.707E+11	3650.7132	10500000.	0.000
184.800	-0.000777	1119878.	-93769.	-1.801E-05	815.2876	2.707E+11	3885.3957	10500000.	0.000
186.900	-0.000806	931547.	-85459.	-1.005E-05	774.1714	2.707E+11	4028.8689	10500000.	0.000
189.000	-0.000819	760975.	-76927.	-3.487E-06	736.9321	2.707E+11	4096.4716	10500000.	0.000
191.100	-0.000820	608461.	-68319.	1.824E-06	703.6353	2.707E+11	4102.0961	10500000.	0.000
193.200	-0.000812	474031.	-59751.	6.022E-06	674.2867	2.707E+11	4058.1641	10500000.	0.000
195.300	-0.000795	357494.	-51315.	9.247E-06	648.8443	2.707E+11	3975.6242	10500000.	0.000
197.400	-0.000773	258486.	-43083.	1.164E-05	627.2289	2.707E+11	3863.9680	10500000.	0.000
199.500	-0.000746	176515.	-35109.	1.332E-05	609.3331	2.707E+11	3731.2592	10500000.	0.000
201.600	-0.000717	110997.	-27427.	1.444E-05	595.0293	2.707E+11	3584.1740	10500000.	0.000
203.700	-0.000686	61285.	-20064.	1.511E-05	584.1761	2.707E+11	3428.0486	10500000.	0.000
205.800	-0.000653	26690.	-13035.	1.545E-05	576.6233	2.707E+11	3266.9318	10500000.	0.000
207.900	-0.000621	6501.3416	-6345.6355	1.558E-05	572.2158	2.707E+11	3103.6413	10500000.	0.000
210.000	-0.000588	0.000	0.000	1.560E-05	570.7964	2.707E+11	2939.8212	5250000.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.2532627	inches
Computed slope at pile head	=	-0.0030743	radians
Maximum bending moment	=	4696879.	inch-lbs
Maximum shear force	=	-126641.	lbs
Depth of maximum bending moment	=	126.0000000	inches below pile head
Depth of maximum shear force	=	172.2000000	inches below pile head
Number of iterations	=	7	
Number of zero deflection points	=	1	

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head	=	21400.000	lbs
Rotation of pile head	=	0.000E+00	radians
Axial load at pile head	=	368000.000	lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0393	-1456375.	21400.	0.000	1070.0400	1.306E+11	0.000	0.000	0.000
2.100	0.0393	-1411426.	21400.	-2.306E-05	1053.0827	1.306E+11	0.000	0.000	0.000
4.200	0.0392	-1366460.	21400.	-4.540E-05	1036.1188	1.306E+11	0.000	0.000	0.000
6.300	0.0391	-1321476.	21400.	-6.702E-05	1019.1484	1.306E+11	0.000	0.000	0.000
8.400	0.0389	-1276476.	21400.	-8.791E-05	1002.1719	1.306E+11	0.000	0.000	0.000
10.500	0.0387	-1231460.	21400.	-0.000108	985.1894	1.306E+11	0.000	0.000	0.000
12.600	0.0385	-1186429.	21400.	-0.000128	968.2011	1.306E+11	0.000	0.000	0.000
14.700	0.0382	-1141383.	21400.	-0.000146	951.2073	1.306E+11	0.000	0.000	0.000
16.800	0.0379	-1096323.	21400.	-0.000164	934.2081	1.306E+11	0.000	0.000	0.000
18.900	0.0375	-1051249.	21400.	-0.000182	917.2037	1.306E+11	0.000	0.000	0.000
21.000	0.0371	-1006162.	21400.	-0.000198	900.1944	1.306E+11	0.000	0.000	0.000
23.100	0.0367	-961063.	21400.	-0.000214	883.1804	1.306E+11	0.000	0.000	0.000
25.200	0.0362	-915952.	21400.	-0.000229	866.1619	1.306E+11	0.000	0.000	0.000
27.300	0.0357	-870829.	21400.	-0.000243	849.1391	1.306E+11	0.000	0.000	0.000
29.400	0.0352	-825696.	21400.	-0.000257	832.1123	1.306E+11	0.000	0.000	0.000
31.500	0.0346	-780552.	21400.	-0.000270	815.0815	1.306E+11	0.000	0.000	0.000
33.600	0.0340	-735398.	21400.	-0.000282	798.0471	1.306E+11	0.000	0.000	0.000
35.700	0.0334	-690236.	21400.	-0.000294	781.0092	1.306E+11	0.000	0.000	0.000
37.800	0.0328	-645065.	21400.	-0.000304	763.9681	1.306E+11	0.000	0.000	0.000
39.900	0.0322	-599886.	21400.	-0.000314	746.9240	1.306E+11	0.000	0.000	0.000
42.000	0.0315	-554699.	21400.	-0.000321	482.6388	2.707E+11	0.000	0.000	0.000

44.100	0.0308	-509509.	21400.	-0.000325	472.7729	2.707E+11	0.000	0.000	0.000
46.200	0.0301	-464316.	21400.	-0.000329	462.9064	2.707E+11	0.000	0.000	0.000
48.300	0.0294	-419120.	21400.	-0.000333	453.0393	2.707E+11	0.000	0.000	0.000
50.400	0.0287	-373922.	21400.	-0.000336	443.1716	2.707E+11	0.000	0.000	0.000
52.500	0.0280	-328721.	21400.	-0.000338	433.3034	2.707E+11	0.000	0.000	0.000
54.600	0.0273	-283519.	21400.	-0.000341	423.4348	2.707E+11	0.000	0.000	0.000
56.700	0.0266	-238315.	21400.	-0.000343	413.5659	2.707E+11	0.000	0.000	0.000
58.800	0.0259	-193109.	21400.	-0.000344	403.6966	2.707E+11	0.000	0.000	0.000
60.900	0.0251	-147902.	21400.	-0.000346	393.8271	2.707E+11	0.000	0.000	0.000
63.000	0.0244	-102694.	21400.	-0.000347	383.9573	2.707E+11	0.000	0.000	0.000
65.100	0.0237	-57486.	21400.	-0.000347	374.0875	2.707E+11	0.000	0.000	0.000
67.200	0.0229	-12277.	21400.	-0.000348	364.2176	2.707E+11	0.000	0.000	0.000
69.300	0.0222	32931.	21400.	-0.000348	368.7267	2.707E+11	0.000	0.000	0.000
71.400	0.0215	78140.	21400.	-0.000347	378.5966	2.707E+11	0.000	0.000	0.000
73.500	0.0208	123348.	21400.	-0.000346	388.4664	2.707E+11	0.000	0.000	0.000
75.600	0.0200	168555.	21400.	-0.000345	398.3361	2.707E+11	0.000	0.000	0.000
77.700	0.0193	213762.	21400.	-0.000344	408.2055	2.707E+11	0.000	0.000	0.000
79.800	0.0186	258967.	21400.	-0.000342	418.0746	2.707E+11	0.000	0.000	0.000
81.900	0.0179	304170.	21400.	-0.000340	427.9434	2.707E+11	0.000	0.000	0.000
84.000	0.0172	349372.	21400.	-0.000337	437.8118	2.707E+11	0.000	0.000	0.000
86.100	0.0165	394571.	21400.	-0.000334	447.6798	2.707E+11	0.000	0.000	0.000
88.200	0.0158	439768.	21400.	-0.000331	457.5472	2.707E+11	0.000	0.000	0.000
90.300	0.0151	484963.	21400.	-0.000328	467.4141	2.707E+11	0.000	0.000	0.000
92.400	0.0144	530155.	21400.	-0.000324	477.2803	2.707E+11	0.000	0.000	0.000
94.500	0.0137	575343.	21400.	-0.000319	487.1458	2.707E+11	0.000	0.000	0.000
96.600	0.0130	620528.	21400.	-0.000315	497.0106	2.707E+11	0.000	0.000	0.000
98.700	0.0124	665709.	21400.	-0.000310	506.8745	2.707E+11	0.000	0.000	0.000
100.800	0.0117	710887.	21400.	-0.000304	516.7376	2.707E+11	0.000	0.000	0.000
102.900	0.0111	756060.	21400.	-0.000299	526.5998	2.707E+11	0.000	0.000	0.000
105.000	0.0105	801228.	21400.	-0.000293	536.4610	2.707E+11	0.000	0.000	0.000
107.100	0.009881	846392.	21400.	-0.000286	546.3211	2.707E+11	0.000	0.000	0.000
109.200	0.009286	891551.	21400.	-0.000279	556.1801	2.707E+11	0.000	0.000	0.000
111.300	0.008707	936704.	21400.	-0.000272	566.0379	2.707E+11	0.000	0.000	0.000
113.400	0.008142	981852.	21400.	-0.000265	575.8946	2.707E+11	0.000	0.000	0.000
115.500	0.007594	1026993.	20383.	-0.000257	585.7499	2.707E+11	-968.4693	267812.	0.000
117.600	0.007062	1067858.	18357.	-0.000249	594.6715	2.707E+11	-961.1842	285806.	0.000
119.700	0.006548	1104478.	16347.	-0.000241	602.6662	2.707E+11	-953.1264	305666.	0.000
121.800	0.006052	1136887.	14355.	-0.000232	609.7418	2.707E+11	-944.2747	327659.	0.000
123.900	0.005574	1165126.	12382.	-0.000223	615.9069	2.707E+11	-934.6054	352098.	0.000
126.000	0.005115	1189236.	10430.	-0.000214	621.1705	2.707E+11	-924.0927	379358.	0.000
128.100	0.004676	1209263.	8501.5758	-0.000205	625.5429	2.707E+11	-912.7081	409891.	0.000
130.200	0.004256	1225258.	6597.7916	-0.000195	629.0350	2.707E+11	-900.4197	444244.	0.000
132.300	0.003857	1237275.	4720.7998	-0.000186	631.6585	2.707E+11	-887.1915	483084.	0.000
134.400	0.003477	1245372.	2872.6165	-0.000176	633.4263	2.707E+11	-872.9831	527238.	0.000
136.500	0.003118	1249612.	1055.3489	-0.000166	634.3519	2.707E+11	-857.7479	577733.	0.000
138.600	0.002779	1250062.	-728.7905	-0.000157	634.4501	2.707E+11	-841.4325	635867.	0.000
140.700	0.002460	1246793.	-2477.4674	-0.000147	633.7365	2.707E+11	-823.9741	703298.	0.000
142.800	0.002162	1239884.	-4188.2039	-0.000137	632.2279	2.707E+11	-805.2987	782178.	0.000
144.900	0.001884	1229415.	-5858.3509	-0.000128	629.9425	2.707E+11	-785.3175	875348.	0.000
147.000	0.001626	1215476.	-7485.0523	-0.000118	626.8993	2.707E+11	-763.9219	986628.	0.000
149.100	0.001388	1198160.	-9065.1966	-0.000109	623.1190	2.707E+11	-740.9773	1121282.	0.000
151.200	0.001169	1177570.	-10595.	-9.958E-05	618.6237	2.707E+11	-716.3122	1286761.	0.000
153.300	0.000969	1153814.	-12072.	-9.054E-05	613.4372	2.707E+11	-689.7026	1493959.	0.000
155.400	0.000789	1127009.	-13490.	-8.170E-05	607.5852	2.707E+11	-660.8466	1759474.	0.000
157.500	0.000626	1097283.	-17472.	-7.307E-05	601.0955	2.707E+11	-3131.8088	10500000.	0.000

159.600	0.000482	1053739.	-23290.	-6.473E-05	591.5891	2.707E+11	-2409.2569	10500000.	0.000
161.700	0.000355	999565.	-27681.	-5.676E-05	579.7616	2.707E+11	-1772.5277	10500000.	0.000
163.800	0.000243	937567.	-30820.	-4.925E-05	566.2263	2.707E+11	-1217.2087	10500000.	0.000
165.900	0.000148	870196.	-32873.	-4.224E-05	551.5179	2.707E+11	-738.2506	10500000.	0.000
168.000	6.603E-05	799564.	-33995.	-3.576E-05	536.0975	2.707E+11	-330.1662	10500000.	0.000
170.100	-2.559E-06	727471.	-34329.	-2.984E-05	520.3582	2.707E+11	12.7972	10500000.	0.000
172.200	-5.930E-05	655430.	-34004.	-2.448E-05	504.6303	2.707E+11	296.5112	10500000.	0.000
174.300	-0.000105	584693.	-33139.	-1.967E-05	489.1870	2.707E+11	526.8432	10500000.	0.000
176.400	-0.000142	516275.	-31841.	-1.540E-05	474.2501	2.707E+11	709.5545	10500000.	0.000
178.500	-0.000170	450984.	-30203.	-1.165E-05	459.9958	2.707E+11	850.2174	10500000.	0.000
180.600	-0.000191	389439.	-28309.	-8.388E-06	446.5594	2.707E+11	954.1495	10500000.	0.000
182.700	-0.000205	332100.	-26229.	-5.590E-06	434.0412	2.707E+11	1026.3635	10500000.	0.000
184.800	-0.000214	279286.	-24026.	-3.218E-06	422.5107	2.707E+11	1071.5293	10500000.	0.000
186.900	-0.000219	231195.	-21753.	-1.239E-06	412.0115	2.707E+11	1093.9485	10500000.	0.000
189.000	-0.000220	187927.	-19452.	3.870E-07	402.5652	2.707E+11	1097.5379	10500000.	0.000
191.100	-0.000217	149497.	-17159.	1.696E-06	394.1754	2.707E+11	1085.8214	10500000.	0.000
193.200	-0.000212	115856.	-14904.	2.725E-06	386.8308	2.707E+11	1061.9290	10500000.	0.000
195.300	-0.000206	86897.	-12709.	3.511E-06	380.5085	2.707E+11	1028.6007	10500000.	0.000
197.400	-0.000198	62473.	-10591.	4.090E-06	375.1763	2.707E+11	988.1949	10500000.	0.000
199.500	-0.000189	42408.	-8563.7589	4.497E-06	370.7956	2.707E+11	942.7010	10500000.	0.000
201.600	-0.000179	26499.	-6635.4821	4.764E-06	367.3223	2.707E+11	893.7531	10500000.	0.000
203.700	-0.000169	14531.	-4812.2620	4.924E-06	364.7096	2.707E+11	842.6470	10500000.	0.000
205.800	-0.000158	6279.6325	-3097.6074	5.004E-06	362.9081	2.707E+11	790.3574	10500000.	0.000
207.900	-0.000148	1513.5090	-1493.2979	5.035E-06	361.8676	2.707E+11	737.5564	10500000.	0.000
210.000	-0.000137	0.000	0.000	5.040E-06	361.5372	2.707E+11	684.6321	5250000.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection             =      0.0393023 inches
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =      -1456375. inch-lbs
Maximum shear force              =        -34329. lbs
Depth of maximum bending moment  =       0.000000 inches below pile head
Depth of maximum shear force     =    170.1000000 inches below pile head
Number of iterations             =              8
Number of zero deflection points =              1
```

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-head Rotation radians
1	1	V = 15000.	M = 2760000.	581000.	0.25326272	4696879.	-126641.	-0.00307432
2	2	V = 21400.	S = 0.000	368000.	0.03930233	-1456375.	-34329.	0.00000000

The analysis ended normally.

Bridge 238 - Bent 1 - Boring B1-B

Required tip resistance

q_{req} = required tip resistance (rounded up to the nearest 10 ksf or 5 tsf)

$$= \frac{\frac{R_{req} - \varphi_{qs} R_{sd}}{A_T}}{\varphi_{tip}} \leq q_p$$

R_{req}		731	kips	Required factored geotechnical resistance
$\varphi_{qs,\ rock}$		0.55		side resistance factor, in Rock
$R_{sd,\ rock}$		0	kips	nominal side resistance, in Rock
$\varphi_{qs,\ IGM}$		0.6		side resistance factor, in IGM
$R_{sd,\ IGM}$		0	kips	nominal side resistance, in IGM
$\varphi_{qs} R_{sd}$		0	kips	factored developed side resistance
A_T		6.30	ft^2	Area of drilled pier tip (smaller than shaft diameter if rock sock
φ_{tip}		0.5		tip resistance factor
q_{req}		232	ksf	required tip resistance
	=	240	ksf	required tip resistance rounded to the nearest 10 ksf
	=	120	tsf	required tip resistance rounded in tsf
q_p		275	tsf	estimated nominal tip resistance

Required Resistance

R_{req} = required resistance

$$= P_r + y_{DL}(W_T - W_{Soil/Rock}) - y_{WA} W_{Water}$$

P_r		725	kips	Maximum factored axial load
y_{DL}		1.25		Factor for Permanent Dead loads from AASHTO Table 3.4.1-2
W_T		18	kips	Unfactored Weight of Drilled Pier and Column
	Pier Diameter	3	ft	
	Pier Length	14	ft	
	Column Diameter	2.5	ft	
	Column Length	3.5	ft	
	Weight of Concrete	0.155	$kips/ft^3$	
$W_{Soil/Rock}$		8	kips	Unfactored Weight of Soil/Rock that will be displaced below the Design Scour Elevation
	Pier Diameter	3	ft	
	Pier Length - Soil	0	ft	Pier Length in Soil Below the Design Scour Elevation
				DSE: 667 Bottom of Soil: 667
	Unit Weight - Soil	0.12	$kips/ft^3$	
	Pier Length - IGM	3.5	ft	Pier Length in IGM Below the Design Scour Elevation
				Top of IGM: 667 Bottom of IGM: 663.5
	Unit Weight - IGM	0.13	$kips/ft^3$	
	Pier Length - Rock	4.5	ft	Pier Length in Rock Below the Design Scour Elevation
				Top of Rock: 663.5 Bottom of Rock: 659
	Unit Weight - Rock	0.15	$kips/ft^3$	
y_{WA}		1		Factor for Water Loads from AASHTO Table 3.4.1-1
W_{water}		6	kips	Unfactored Weight of Water Displaced
	Unit Weight - Water	0.0624	$kips/ft^3$	

APPENDIX B-3 – BENT 2, BORING B2-A

BORING B2-A WITH RELEVANT ELEVATIONS
AXIAL CALCULATIONS
L-PILE ANALYSES
REQUIRED TIP RESISTANCE CALCULATIONS

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B2-A	**STATION** 12+88	**OFFSET** 4 ft LT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 684.5 ft	**TOTAL DEPTH** 41.0 ft	**NORTHING** 829,366	**EASTING** 1,782,637	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	ELEV. (ft)	DEPTH (ft)
685												
										GROUND SURFACE	684.5	0.0
										Asphalt (0.5 ft)	684.0	0.5
										Concrete (0.6 ft)	683.4	1.1
	681.0	3.5								**ROADWAY EMBANKMENT**		
680			2	1	2	3		M		Tan, sandy CLAY		
	676.0	8.5									676.0	8.5
675			1	1	WOH	1		M		Yellowish-tan and brown sandy CLAY with gravel		
	671.0	13.5									672.5	12.0
670			WOH	WOH	WOH			W		**ALLUVIAL** Light gray clayey SAND with gravel		
	666.0	18.5									666.0	18.5
665			60/0			0 60/0				**CRYSTALLINE ROCK** Metamorphosed Granite		
660												
655												
650												
645											643.5	41.0

B.O.C. ~ 677.5

T.O.S. ~ 673

Scour ~ 666

P.O.F. ~ 662.5

TIP ~ 661

Boring Terminated at Elevation 643.5 ft in Crystalline Rock (Metamorphosed Granite)

1) Advanced 3-7/8" tricone carb. bit to 18.5 feet.
2) Advanced NW casing to 18.5 feet.
3) Advanced NQ2 core barrel from 18.5 feet to 41.0 feet.
4) Used creek water and bentonite as drilling fluid.

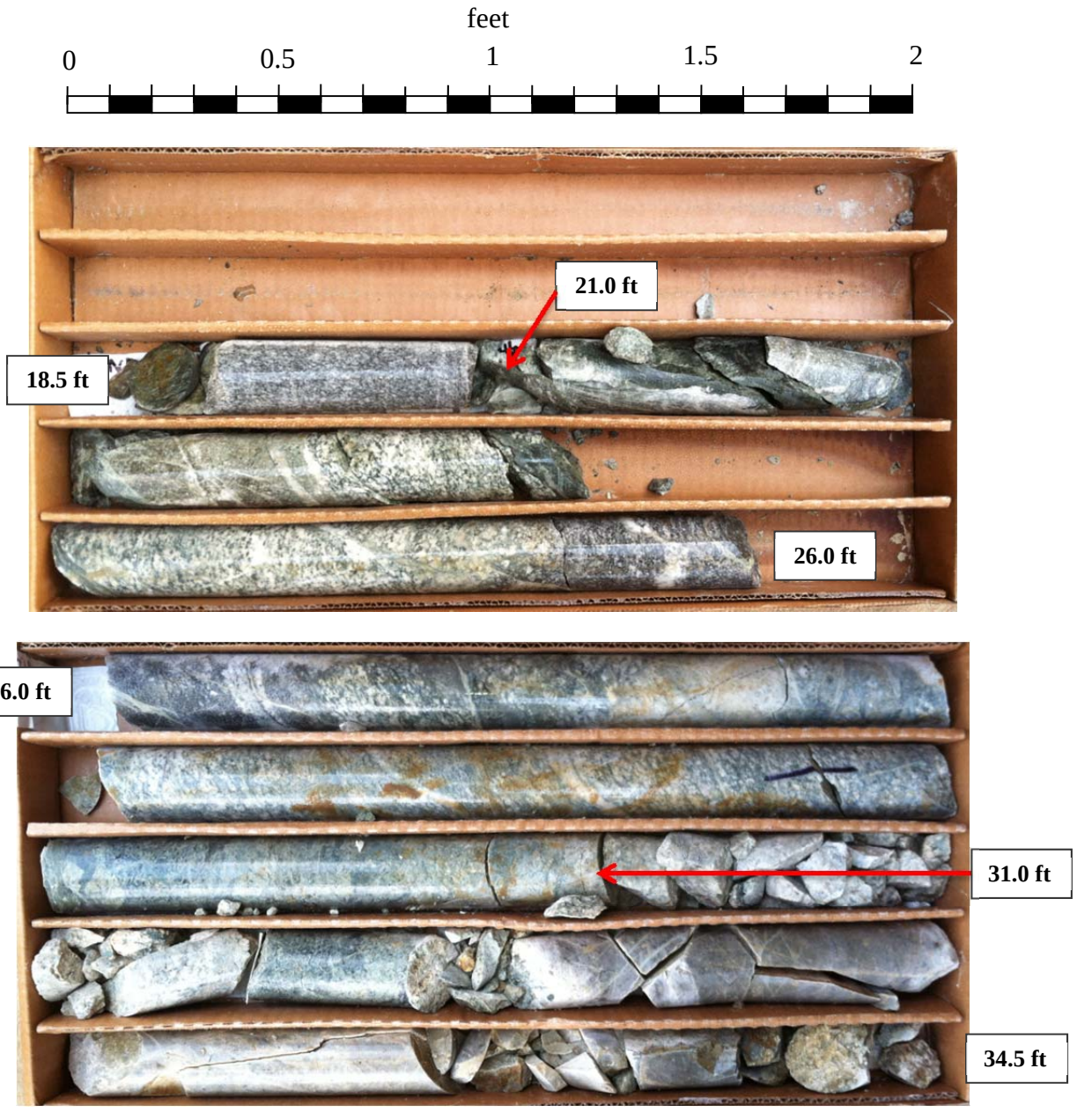
NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			**GROUND WTR (ft)**
BORING NO. B2-A	**STATION** 12+88	**OFFSET** 4 ft LT	**ALIGNMENT** L — **0 HR.** N/A
COLLAR ELEV. 684.5 ft	**TOTAL DEPTH** 41.0 ft	**NORTHING** 829,366	**EASTING** 1,782,637 — **24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/11/12	**COMP. DATE** 06/11/12	**SURFACE WATER DEPTH** N/A
CORE SIZE NQ2	**TOTAL RUN** 22.5 ft		

ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS
665.96											Begin Coring @ 18.5 ft
665	666.0	18.5	2.5	3:37/1.0 1:15/1.0 0:48/0.5	(0.8) 32%	(0.5) 20%		(18.3) 81%	(6.8) 30%		666.0 ELEV. (ft) — 18.5 DEPTH (ft) **CRYSTALLINE ROCK** White and gray, fresh to moderately severe weathering, hard to very soft, METAMORPHOSED GRANITE, with moderately close to very close fracture spacing
	663.5	21.0	5.0	4:02/1.0 3:52/1.0 4:12/1.0 4:04/1.0 4:46/1.0	(3.5) 70%	(1.3) 26%					TIP ~ 661
660	658.5	26.0	5.0	4:49/1.0 4:22/1.0 4:55/1.0 3:50/1.0 3:16/1.0	(5.0) 100%	(3.8) 76%					
655	653.5	31.0	5.0	2:37/1.0 3:36/1.0 4:24/1.0 3:54/1.0 4:01/1.0	(4.8) 96%	(0.0) 0%					
650	648.5	36.0	5.0	3:57/1.0 4:56/1.0 4:48/1.0 5:33/1.0 4:55/1.0	(4.2) 84%	(1.2) 24%					
645	643.5	41.0									643.5 ELEV. (ft) — 41.0 DEPTH (ft) Boring Terminated at Elevation 643.5 ft in Crystalline Rock (Metamorphosed Granite) 1) Advanced 3-7/8" tricone carb. bit to 18.5 feet. 2) Advanced NW casing to 18.5 feet. 3) Advanced NQ2 core barrel from 18.5 feet to 41.0 feet. 4) Used creek water and bentonite as drilling fluid.

North Carolina Department of Transportation
Geotechnical Unit
Rock Core Photo

T.I.P. No..: 17BP.7.R.37	*Bridge No.*: 400238	*County*: Guilford	*Boring Location:* **B2-A**
Site Description: Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			
Driller: W. Duggins	*Core Size*: NQ2	*Drill Machine:* Diedrich D-50	
Geologist / Engineer: T. Bartlett	*Total Run Length:* 22.5 feet	*Date:* 6/11/2012	



Notes:
1) Used NQ2 core barrel with wire line

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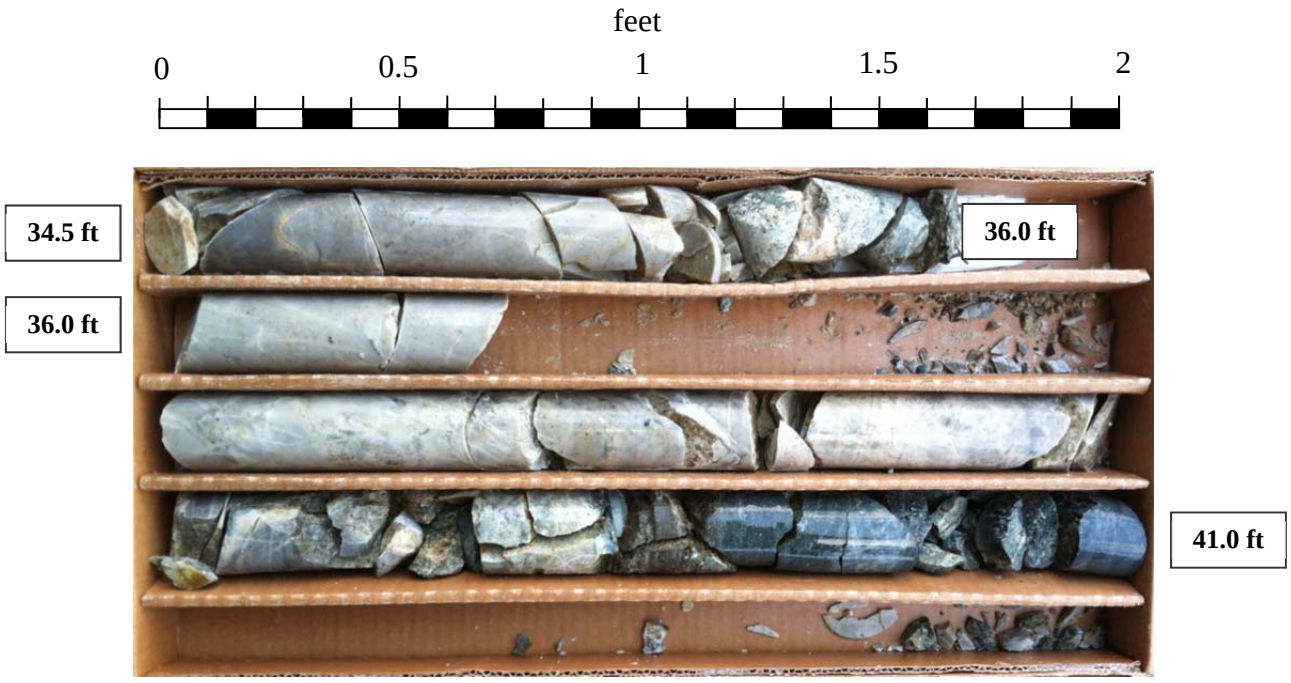
North Carolina Department of Transportation
Geotechnical Unit
Rock Core Photo

T.I.P. No.: 17BP.7.R.37	*Bridge No.*: 400238	*County*: Guilford	*Boring Location:* **B2-A**
Site Description: Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek			
Driller: W. Duggins	*Core Size*: NQ2	*Drill Machine:* Diedrich D-50	
Geologist / Engineer: T. Bartlett	*Total Run Length:* 22.5 feet	*Date:* 6/11/2012	



Notes:
1) Used NQ2 core barrel with wire line

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Terracon

Analysis Performed By:	*JPM*
Date of Analysis:	*11/6/2012*
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT TIP RESISTANCE IN SOIL, IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2A*	
Boring Elevation:	*673.00*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	*ft*
Shaft Length:	*12*	*ft (below grade)*	**Tip Elevation:**	*661.00*	*ft MSL*	**Cross-section Area:**	*7.1*	*ft²*
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	*ft*

Type of Material at the Tip:	**Rock**

f_c': concrete compressive strength =	**4.50**	ksi

For Soil Section 10.8.3.5.2c, *2010 AASHTO LRFD Bridge Design Specifications*

Cohesionless Soils: $N_{60} \le 50$, $q_p = 1.2*N_{60}$ Equation 10.8.3.5.2c-1, *2010 AASHTO LRFD Bridge Design Specifications*

Cohesive Soils: $N_c = 6(1+0.2(Z/D)) \le 9$ $q_p = N_c * S_u \le 80$ where Z= penetration of shaft in bearing layer

S_u = ksf

Z = ft

N_c =

Cohesionless Soils: **Unit Tip Resistance in Soil, q_p =** (q_p is limited to a maximum of 60 ksf)

Cohesive Soils: **Unit Tip Resistance in Soil, q_p =** (q_p is limited to a maximum of 80 ksf)

For IGM (IGM: Cohesionless soils with blow counts greater than 50 blows/ft, i.e., Very Dense/Hard Soils and PWR)
Section 10.8.3.5.2c, *2010 AASHTO LRFD Bridge Design Specifications*

$$q_p = 0.59 \left[N_{60} \left\{ \frac{p_a}{\sigma'_v} \right\} \right]^{0.8} \sigma'_v$$

Equation 10.8.3.5.2c-2, *2010 AASHTO LRFD Bridge Design Specifications*

Material unit weight at tip =	0.14	kcf		Depth of the tip:	12	ft	Water Level (ft):	0 ft
N: Uncorrected SPT Blow Count at the Tip =	1000	blows/ft		N_{60}* = (ER/60%)N =	100	blows/ft	Type of Hammer:	auto
p_a: atmospheric pressure =	2.12	ksf		σ'_v : vertical effective stress at tip =	0.72	ksf	ER: Hammer Efficiency:	80%

*N_{60} is limited to a maximum of 100 bpf

Unit Tip Resistance in IGM, q_p =

For Rock

$q_p = A + q_u [m_b (A/q_u) + s]^a$ where $A = \sigma'_v + q_u [m_b (\sigma'_v/q_u) + s]^a$

Reference: Turner (2006). *NCHRP Synthesis 360 Rock-Socketed Shafts for Highways Structure Foundations* . Transportation Research Board of National Academies. 136 pp.

q_u: unconfined compressive strength of intact rock — s, a : constant for the Rock Mass — GSI: Geological Strength Index — $GSI^* \approx 18.7e^{(0.0152RQD)}$

m_b: Reduced Value of m_i — $s = \exp^{((GSI-100)/9)}$ — $m_b = m_i (\exp^{((GSI-100)/28)})$ — $a = 1/2 + 1/6(e^{-GSI/15} - e^{-20/3})$ — RQD: Rock Quality Designation

q_u =	1,152	ksf	m_i =	29		RQD =	50	%	A =	63.71	ksf
GSI =	40	s =	1.27E-03	a =	0.51	m_b =	3.40				

* Correlation defined by Truzman et. al. (2011) "Determination of Unit Tip Resistance for Drilled Shafts in Fractured Rocks using the Global Rock Mass Strength", 2011 Pan-Am CGS Geotechnical Conference

Unit Tip Resistance in Rock, q_p = **556** **ksf in Rock** **<** **fc' =** **648** **ksf**

NOTE: Please input the required data where indicated in Blue. When calculating Tip Resistance in Cohesive Soil, please input an Undrained Shear Strength value, Su, into the "Side in Soils (using a-method)" sheet for the bearing layer to generate a tip resistance in cohesive soils output on this sheet. When calculating Tip Resistance in IGM, no data needs to be input onto this sheet other than indicating IGM or Rock as the material at the tip, and the Project Information at the top of the sheet. Please input all soil strata data and shaft information into the "Side in Soils (using B-method)" sheet to generate a tip resistance in IGM output on this sheet. You should always check the input and output values on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/6/2012***
Analysis Reviewed By:	

DRILLED SHAFT SIDE RESISTANCE CALCULATION USING β-METHOD

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*12*	*ft (below grade)*	**Tip Elevation:**	*661*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*			

UNIT SIDE RESISTANCE (q_s) (*Section 10.8.3.5.2b, 2010 AASHTO LRFD Bridge Design Specifications*)

$q_s = \beta\sigma_v'$ ≤ 4.0 ksf for 0.25 ≤ β ≤ 1.2 (Eq. 10.8.3.5.2b-1)

For N_{60} ≤ 15	$\beta = (1.5 - 0.135\,(z)^{0.5})\,N_{60}/15$		
For N_{60} ≥ 15	$\beta = 1.5 - 0.135\,(z)^{0.5}$ (sandy soils)	or	$\beta = 2.0 - 0.06\,(z)^{0.75}$ (gravelly sands and gravels)
N_{60} = (ER/60%)N	N_{60}: SPT blow count corrected for hammer efficiency (blows/ft)		N: uncorrected SPT blow count
σ'_v = vertical effective stress	Hammer efficiency = 80%	Type of Hammer: auto	Water Level (ft): 0 ft

# of Layers:	2	Layer the Tip is located in:	2

Layer	USCS	Soil Type	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	β	Check if 0.25<β<1.2	q_s (ksf)	Check if $q_s \le 4.0$ ksf	Q_{si} (kips)
1	CL	Clay	0	7	0.110	3.5	0.167	0	0					
2	Rock	Rock	7	30	0.140	9.5	0.527	1000				Rock		

Total Skin Friction in Soils, $\Sigma(Q_{s,soils})_i$ = 0

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/6/2012***
Analysis Reviewed By:	

DRILLED SHAFT SIDE RESISTANCE CALCULATION USING α-METHOD

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*12*	*ft (below grade)*	**Tip Elevation:**	*661*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*			

UNIT SIDE RESISTANCE (q_s) (*Section 10.8.3.5.1b, 2010 AASHTO LRFD Bridge Design Specifications*)

$q_s = \alpha S_u$ (Eq. 10.8.3.5.1b-1)

For $S_u/p_a \leq 1.5$	$\alpha = 0.55$			
For $1.5 \leq S_u/p_a \leq 2.5$	$\alpha = 0.55 - 0.1(S_u/p_a - 1.5)$	Su = undrained shear strength (ksf)	α = adhesion factor	p_a = atm. pressure = 2.12 ksf
N_{60} = (ER/60%)N	N_{60}: SPT blow count corrected for hammer efficiency (blows/ft)			N: uncorrected SPT blow count
σ'_v = vertical effective stress	Hammer efficiency = 80%	Type of Hammer: auto		Water Level (ft): 0 ft

# of Layers:	2	Layer the Tip is located in:	2

Layer	USCS	Soil Type	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	S_u (ksf)	S_u/p_a	α	q_s (ksf)	Q_{si} (kips)
1	CL	Clay	0	7	0.110	3.5	0.167	0	0	0.00	0.00	0.55	0.00	0
2	Rock	Rock	7	30	0.140	9.5	0.527	1000		0.00		Rock		

Total Skin Friction in Soils, $\Sigma(Q_{s,soils})_i$ = 0

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/6/2012***
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR WEAK ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*12*	*ft (below grade)*	**Tip Elevation:**	*661*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	ft

UNIT SIDE RESISTANCE (q_s) for COHESIONLESS IGM SOILS (*Section 10.8.3.5.5, 2010 AASHTO LRFD Bridge Design Specifications*)

$$q_s = \sigma'_v K_o \tan \Phi'$$

Equation referenced from Chapter 11, *Drilled Shafts: Construction Procedures and Design Methods*, FHWA Publication No. FHWA-IF-99-025, O'Neill and Reese, August, 1999.

IGM: Very Hard/Very Dense Cohesionless Soils and PWR with SPT N_{60} > 50 blows-per-foot		N_{60} = (ER/60%)N = SPT N-value corrected for Hammer Efficiency		
$\Phi' = \tan^{-1}((N_{60}/(12.3+20.3(\sigma'_v/p_a)))^{0.34}$	Φ' = effective stress friction angle of IGM	N: Uncorrected SPT N-Value along the shaft		
$K_o = (1-\sin\Phi')OCR^{\sin\Phi'}$	K_o = in-situ coefficient of lateral earth pressure	Hammer Efficiency, ER =	80%	
$OCR = \sigma'_p/\sigma'_v$	σ'_v = vertical effective stress	Type of hammer =	auto	
$\sigma'_p = 0.2N_{60}p_a$	σ'_p = vertical effective stress	Atmospheric Pressure, p_a =	2.12	ksf

# of Layers: 2

Layer	Material	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	ϕ' (degrees)	σ'_p (ksf)	OCR	K_o	q_s ** (ksf)	Q_s (kips)
1	CL	0	7	0.110	3.5	0.167	0	0				Not IGM		
2	Rock	7	30	0.140	9.5	0.527	1000					Not IGM		

*****Unit Side Resistance, qs, has been reduced by 50% of its calculated value based on past local experience in IGM Materials.***

Total Skin Friction in IGM, $\Sigma(Q_{s,IGM})_i$ = 0

NOTE: No data needs to be input on this sheet to calculate skin resistance in IGM. Please input all soil strata information into the "Side in Soils" sheet to generate a skin resistance in IGM output on this sheet. You should always check the input and output information on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	*JPM*
Date of Analysis:	*11/6/2012*
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*12*	*ft (below grade)*	**Tip Elevation:**	*661*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	ft

UNIT SIDE RESISTANCE (q_s) for DRILLED SHAFTS in ROCK (*Section 10.8.3.5.4b, 2010 AASHTO LRFD Bridge Design Specifications*)

$$q_s = 0.65\,\alpha_E\,p_a\,(q_u/p_a)^{0.5} < 7.8\,p_a\,(f_c'/p_a)^{0.5}$$ (Equation 10.8.3.5.4b-1)

For Rock Layer 1

p_a: atmospheric pressure =		2.12	ksf	f_c': concrete compressive strength =		4.50	ksi
q_u: unconfined compressive strength of rock =	1152	ksf		E_m/E_i: reduction factor (determined from Table 10.4.6.5-1) =		0.05	
RQD =	20 %	GSI =	20	α_E = reduction factor to account for jointing in rock =		0.45	

q_s = 14.46 ksf ≤ 24.09 ksf

calculation of qs is OK **use qs = 14.46 ksf for Rock Layer 1**

For Rock Layer 2

p_a: atmospheric pressure =		2.12	ksf	f_c': concrete compressive strength =		4.50	ksi
q_u: unconfined compressive strength of rock =		ksf		E_m/E_i: reduction factor (determined from Table 10.4.6.5-1) =		0.05	
RQD =	%	GSI =		α_E = reduction factor to account for jointing in rock =		0.45	

q_s = 0.00 ksf ≤ 24.09 ksf

calculation of qs is OK **use qs = 0.00 ksf for Rock Layer 2**

AREA OF SHAFT SIDE SURFACE (As) in ROCK

Length in Layer 1 =	5	ft
Length in Layer 2 =		ft
Socket Diameter =	2.8333	ft
Socket perimeter =	8.90	ft

A_s = 44.51 ft^2

Total Skin Friction in Rock, $Q_{s,rock}$ = 643 kips

NOTE: When calculating side resistance in Rock on this sheet, please input the required input data where indicated in Blue. Please input all rock/soil data and shaft information correctly into the "Tip" sheet to generate a Skin Resistance in Rock output on this sheet. You should always check the input and output values on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/6/2012***
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Left*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2A*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*12*	*ft (below grade)*	**Tip Elevation:**	*661*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	0.0	ft

Table 10.5.5.2.4-1 Resistance Factors for Geotechnical resistance of Drilled Shafts (2010 AASHTO LRFD Bridge Design Specifications)

Method/Soil/Condition			Resistance Factor
Nominal Axial Compressive Resistance of Single-Drilled Shafts, φ_{stat}	Side resistance in clay	α-method (O'Neill and Reese, 1999)	0.45
	Tip resistance in clay	Total Stress (O'Neill and Reese, 1999)	0.40
	Side resistance in sand	β-method (O'Neill and Reese, 1999)	0.55
	Tip resistance in sand	O'Neill and Reese (1999)	0.50
	Side resistance in IGMs	O'Neill and Reese (1999)	0.60
	Tip resistance in IGMs	O'Neill and Reese (1999)	0.55
	Side resistance in rock	Horvath and Kenney (1979)	0.5
	Tip resistance in rock	O'Neill and Reese (1999)	0.50
Static Load Test (compression), φ_{load}	All Materials		Values in Table 10.5.5.2.3-2, but no greater than 0.70

Nominal Shaft Tip Resistance (R_p)

$R_p = q_p \times A_p$ (Equation 10.8.3.5-2)

q_p = 556 ksf A_p = 6.30 ft^2 **R_p = 3,504 kips** ***(In Rock)***

Nominal Shaft Side Resistance (R_s)

$R_s = q_s \times A_s$ (Equation 10.8.3.5-3)

$R_{s,clay}$ = 0 kips **$R_{s,sand}$ = 0 kips** **$R_{s,IGM}$ = 0 kips** **$R_{s,rock}$ = 643 kips**

Total Nominal Resistance ($R_p + R_s$) = 4,147 kips equivalent to **18,447 kN**

REDUCTION DUE TO GROUP EFFECTS

$0.65 \le \eta \le 1.00$ for $2.5*dia. \le$ Distance Between Shafts $\le 6*dia.$ (Section 10.8.3.6.3)

Distance Between Shafts = 18 **feet** **η = 1.00**

FACTORED RESISTANCE OF SINGLE DRILLED SHAFT

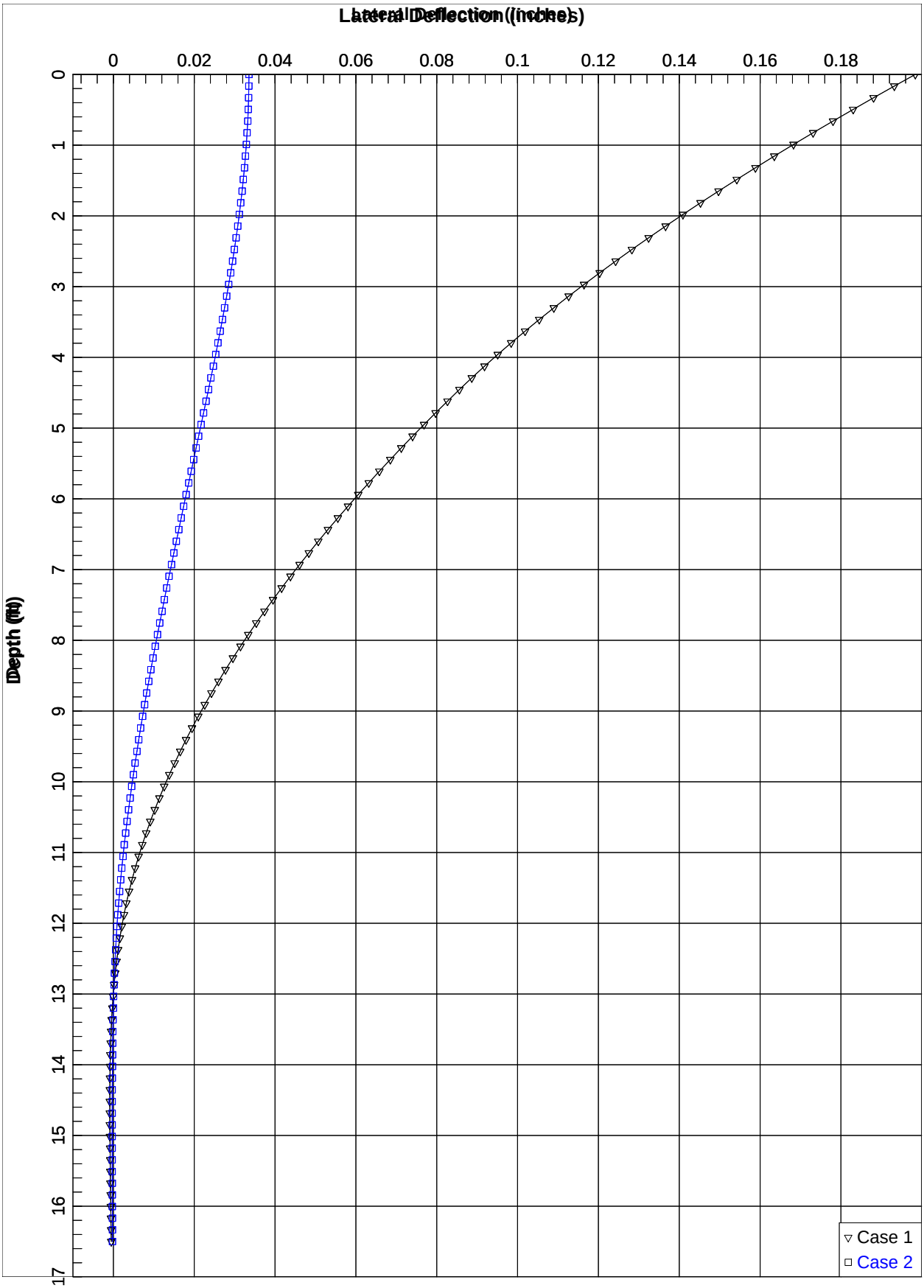
$R_R = \varphi R_n = \varphi_{qp} R_p + \varphi_{qs} R_s$ (Equation 10.8.3.5-1)

φ_{qp} = resistance factor for tip resistance specified in Table 10.5.5.2.4-1

φ_{qs} = resistance factor for shaft side resistance specified in Table 10.5.5.2.4-1

φ_{qp} =	0.50	Rock									
φ_{qs} =	0.45	Clay	φ_{qs} =	0.55	Sand	φ_{qs} =	0.60	IGM	φ_{qs} =	0.55	Rock

Total Factored Resistance, R_R = 2,106 kips


Lateral Deflection (inches)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Case 1
Case 2

LPile Plus for Windows, Version 6 (6.0.28)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Serial Number of Security Device: 156316250
Company Name Stored in Security Device: WPC, Inc.

Files Used for Analysis

Path to file locations: N:\Projects\2011\71115060\Working Files\Bridge 238\Calculations-Analyses\
Name of input data file: Bridge 238 - B2A.lp6d
Name of output report file: Bridge 238 - B2A.lp6o
Name of plot output file: Bridge 238 - B2A.lp6p
Name of runtime messeage file: Bridge 238 - B2A.lp6r

Date and Time of Analysis

Date: November 8, 2012 Time: 8:59:47

Problem Title

Low Impact Bridge 238 - Guilford County

71115060

KHA

Terracon

Boring B2A - Bent 2

Program Options

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes pile response to lateral loading and will compute nonlinear moment-curvature and nominal moment capacity for selected section types.

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total Number of Sections = 2

Total Pile Length = 16.50 ft

Depth of ground surface below top of pile = 11.50 ft

Pile dimensions used for p-y curve computations defined using 4 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	30.0000000
2	4.500000	30.0000000

3	4.500000	36.0000000
4	16.500000	36.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	4.500 ft
Top Width	=	30.000 in
Bottom Width	=	30.000 in
Top Area	=	706.858347 sq. in
Bottom Area	=	706.858347 sq. in
Moment of Inertia at Top	=	39760.782 in^4
Moment of Inertia at Bottom	=	39760.782 in^4
Elastic Modulus	=	3823676. lbs/in^2

Pile Section No. 2:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	12.000 ft
Top Width	=	36.000 in
Bottom Width	=	36.000 in
Top Area	=	1017.876020 sq. in
Bottom Area	=	1017.876020 sq. in
Moment of Inertia at Top	=	82447.958 in^4
Moment of Inertia at Bottom	=	82447.958 in^4
Elastic Modulus	=	3823676. lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 1 layers

Layer 1 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 11.500 ft
Distance from top of pile to bottom of layer = 34.000 ft

(Depth of lowest layer extends 17.50 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 2 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	11.50	80.00000
2	34.00	80.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Test Type	Friction Test Prop.	qu Elas. Subgr. psi	RQD percent	Epsilon 50	J	kpy pci	Rock Emass psi	krm	Friction Ang., deg.	Elas. Subgr. pci
1	Vuggy Limestone	11.500	80.000	--	--	--	5000.000	--	--	--	--	--	--	--	--
		34.000	80.000	--	--	--	5000.000	--	--	--	--	--	--	--	--

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load	Load	Condition	Condition	Axial Thrust

No.	Type	1	2	Force, lbs
1	1	V = 15000. lbs	M = 2760000. in-lbs	581000.
2	2	V = 22000. lbs	S = 0.0000 in/in	368000.

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Moment-Curvature properties derived from elastic section properties

Pile Section No. 2:

Moment-Curvature properties derived from elastic section properties

---

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Horizontal shear force at pile head = 15000.000 lbs
Applied moment at pile head = 2760000.000 in-lbs
Axial thrust load on pile head = 581000.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1984	2760000.	15000.	-0.002646	1863.1739	1.520E+11	0.000	0.000	0.000
1.980	0.1932	2792724.	15000.	-0.002610	1875.5190	1.520E+11	0.000	0.000	0.000
3.960	0.1881	2825405.	15000.	-0.002574	1887.8484	1.520E+11	0.000	0.000	0.000
5.940	0.1830	2858045.	15000.	-0.002537	1900.1618	1.520E+11	0.000	0.000	0.000
7.920	0.1780	2890641.	15000.	-0.002499	1912.4591	1.520E+11	0.000	0.000	0.000
9.900	0.1731	2923195.	15000.	-0.002461	1924.7400	1.520E+11	0.000	0.000	0.000
11.880	0.1683	2955704.	15000.	-0.002423	1937.0044	1.520E+11	0.000	0.000	0.000

13.860	0.1635	2988169.	15000.	-0.002384	1949.2521	1.520E+11	0.000	0.000	0.000
15.840	0.1588	3020590.	15000.	-0.002345	1961.4829	1.520E+11	0.000	0.000	0.000
17.820	0.1542	3052965.	15000.	-0.002306	1973.6966	1.520E+11	0.000	0.000	0.000
19.800	0.1497	3085294.	15000.	-0.002266	1985.8931	1.520E+11	0.000	0.000	0.000
21.780	0.1453	3117577.	15000.	-0.002225	1998.0721	1.520E+11	0.000	0.000	0.000
23.760	0.1409	3149814.	15000.	-0.002184	2010.2335	1.520E+11	0.000	0.000	0.000
25.740	0.1366	3182003.	15000.	-0.002143	2022.3772	1.520E+11	0.000	0.000	0.000
27.720	0.1324	3214145.	15000.	-0.002102	2034.5028	1.520E+11	0.000	0.000	0.000
29.700	0.1283	3246238.	15000.	-0.002059	2046.6102	1.520E+11	0.000	0.000	0.000
31.680	0.1243	3278283.	15000.	-0.002017	2058.6994	1.520E+11	0.000	0.000	0.000
33.660	0.1203	3310279.	15000.	-0.001974	2070.7699	1.520E+11	0.000	0.000	0.000
35.640	0.1164	3342225.	15000.	-0.001931	2082.8218	1.520E+11	0.000	0.000	0.000
37.620	0.1127	3374121.	15000.	-0.001887	2094.8548	1.520E+11	0.000	0.000	0.000
39.600	0.1090	3405966.	15000.	-0.001843	2106.8687	1.520E+11	0.000	0.000	0.000
41.580	0.1054	3437761.	15000.	-0.001798	2118.8634	1.520E+11	0.000	0.000	0.000
43.560	0.1018	3469504.	15000.	-0.001753	2130.8386	1.520E+11	0.000	0.000	0.000
45.540	0.0984	3501195.	15000.	-0.001708	2142.7942	1.520E+11	0.000	0.000	0.000
47.520	0.0951	3532833.	15000.	-0.001662	2154.7301	1.520E+11	0.000	0.000	0.000
49.500	0.0918	3564419.	15000.	-0.001616	2166.6459	1.520E+11	0.000	0.000	0.000
51.480	0.0887	3595951.	15000.	-0.001569	2178.5416	1.520E+11	0.000	0.000	0.000
53.460	0.0856	3627430.	15000.	-0.001522	2190.4170	1.520E+11	0.000	0.000	0.000
55.440	0.0827	3658854.	15000.	-0.001487	1369.5957	3.153E+11	0.000	0.000	0.000
57.420	0.0797	3690251.	15000.	-0.001464	1376.4504	3.153E+11	0.000	0.000	0.000
59.400	0.0769	3721622.	15000.	-0.001441	1383.2992	3.153E+11	0.000	0.000	0.000
61.380	0.0740	3752966.	15000.	-0.001417	1390.1422	3.153E+11	0.000	0.000	0.000
63.360	0.0712	3784283.	15000.	-0.001394	1396.9793	3.153E+11	0.000	0.000	0.000
65.340	0.0685	3815572.	15000.	-0.001370	1403.8104	3.153E+11	0.000	0.000	0.000
67.320	0.0658	3846834.	15000.	-0.001346	1410.6355	3.153E+11	0.000	0.000	0.000
69.300	0.0632	3878069.	15000.	-0.001321	1417.4546	3.153E+11	0.000	0.000	0.000
71.280	0.0606	3909275.	15000.	-0.001297	1424.2675	3.153E+11	0.000	0.000	0.000
73.260	0.0580	3940453.	15000.	-0.001272	1431.0742	3.153E+11	0.000	0.000	0.000
75.240	0.0555	3971602.	15000.	-0.001247	1437.8748	3.153E+11	0.000	0.000	0.000
77.220	0.0531	4002723.	15000.	-0.001222	1444.6690	3.153E+11	0.000	0.000	0.000
79.200	0.0507	4033815.	15000.	-0.001197	1451.4570	3.153E+11	0.000	0.000	0.000
81.180	0.0484	4064877.	15000.	-0.001172	1458.2386	3.153E+11	0.000	0.000	0.000
83.160	0.0461	4095911.	15000.	-0.001146	1465.0138	3.153E+11	0.000	0.000	0.000
85.140	0.0438	4126914.	15000.	-0.001120	1471.7825	3.153E+11	0.000	0.000	0.000
87.120	0.0416	4157888.	15000.	-0.001094	1478.5447	3.153E+11	0.000	0.000	0.000
89.100	0.0395	4188832.	15000.	-0.001068	1485.3003	3.153E+11	0.000	0.000	0.000
91.080	0.0374	4219746.	15000.	-0.001042	1492.0494	3.153E+11	0.000	0.000	0.000
93.060	0.0354	4250629.	15000.	-0.001015	1498.7918	3.153E+11	0.000	0.000	0.000
95.040	0.0334	4281481.	15000.	-0.000988	1505.5274	3.153E+11	0.000	0.000	0.000
97.020	0.0314	4312303.	15000.	-0.000961	1512.2564	3.153E+11	0.000	0.000	0.000
99.000	0.0296	4343093.	15000.	-0.000934	1518.9785	3.153E+11	0.000	0.000	0.000
100.980	0.0277	4373852.	15000.	-0.000907	1525.6938	3.153E+11	0.000	0.000	0.000
102.960	0.0260	4404579.	15000.	-0.000879	1532.4021	3.153E+11	0.000	0.000	0.000
104.940	0.0243	4435275.	15000.	-0.000851	1539.1036	3.153E+11	0.000	0.000	0.000
106.920	0.0226	4465938.	15000.	-0.000823	1545.7980	3.153E+11	0.000	0.000	0.000
108.900	0.0210	4496569.	15000.	-0.000795	1552.4854	3.153E+11	0.000	0.000	0.000
110.880	0.0195	4527168.	15000.	-0.000767	1559.1657	3.153E+11	0.000	0.000	0.000
112.860	0.0180	4557734.	15000.	-0.000738	1565.8388	3.153E+11	0.000	0.000	0.000
114.840	0.0165	4588267.	15000.	-0.000710	1572.5048	3.153E+11	0.000	0.000	0.000
116.820	0.0152	4618767.	15000.	-0.000681	1579.1635	3.153E+11	0.000	0.000	0.000
118.800	0.0138	4649234.	15000.	-0.000652	1585.8150	3.153E+11	0.000	0.000	0.000
120.780	0.0126	4679667.	15000.	-0.000622	1592.4591	3.153E+11	0.000	0.000	0.000

122.760	0.0114	4710066.	15000.	-0.000593	1599.0958	3.153E+11	0.000	0.000	0.000
124.740	0.0102	4740431.	15000.	-0.000563	1605.7251	3.153E+11	0.000	0.000	0.000
126.720	0.009144	4770762.	15000.	-0.000533	1612.3469	3.153E+11	0.000	0.000	0.000
128.700	0.008118	4801058.	15000.	-0.000503	1618.9612	3.153E+11	0.000	0.000	0.000
130.680	0.007151	4831320.	15000.	-0.000473	1625.5679	3.153E+11	0.000	0.000	0.000
132.660	0.006244	4861546.	15000.	-0.000443	1632.1670	3.153E+11	0.000	0.000	0.000
134.640	0.005398	4891738.	15000.	-0.000412	1638.7584	3.153E+11	0.000	0.000	0.000
136.620	0.004613	4921894.	15000.	-0.000381	1645.3422	3.153E+11	0.000	0.000	0.000
138.600	0.003889	4952015.	-4248.6148	-0.000350	1651.9181	3.153E+11	-19443.	9900000.	0.000
140.580	0.003226	4905876.	-39466.	-0.000319	1641.8449	3.153E+11	-16130.	9900000.	0.000
142.560	0.002624	4796465.	-68425.	-0.000289	1617.9584	3.153E+11	-13122.	9900000.	0.000
144.540	0.002082	4635576.	-91724.	-0.000259	1582.8333	3.153E+11	-10412.	9900000.	0.000
146.520	0.001598	4433834.	-109943.	-0.000231	1538.7891	3.153E+11	-7990.5390	9900000.	0.000
148.500	0.001169	4200734.	-123639.	-0.000204	1487.8988	3.153E+11	-5844.6536	9900000.	0.000
150.480	0.000792	3944691.	-133346.	-0.000178	1431.9994	3.153E+11	-3959.9630	9900000.	0.000
152.460	0.000464	3673094.	-139564.	-0.000154	1372.7045	3.153E+11	-2320.5469	9900000.	0.000
154.440	0.000182	3392373.	-142761.	-0.000132	1311.4177	3.153E+11	-909.5178	9900000.	0.000
156.420	-5.812E-05	3108062.	-143374.	-0.000111	1249.3470	3.153E+11	290.5790	9900000.	0.000
158.400	-0.000259	2824867.	-141802.	-9.283E-05	1187.5202	3.153E+11	1297.4216	9900000.	0.000
160.380	-0.000426	2546739.	-138410.	-7.596E-05	1126.7993	3.153E+11	2128.6186	9900000.	0.000
162.360	-0.000560	2276937.	-133530.	-6.081E-05	1067.8963	3.153E+11	2801.4634	9900000.	0.000
164.340	-0.000667	2018102.	-127457.	-4.733E-05	1011.3875	3.153E+11	3332.7320	9900000.	0.000
166.320	-0.000748	1772318.	-120456.	-3.542E-05	957.7280	3.153E+11	3738.5182	9900000.	0.000
168.300	-0.000807	1541177.	-112761.	-2.502E-05	907.2655	3.153E+11	4034.1046	9900000.	0.000
170.280	-0.000847	1325841.	-104576.	-1.601E-05	860.2534	3.153E+11	4233.8631	9900000.	0.000
172.260	-0.000870	1127093.	-96077.	-8.311E-06	816.8629	3.153E+11	4351.1830	9900000.	0.000
174.240	-0.000880	945396.	-87415.	-1.803E-06	777.1949	3.153E+11	4398.4220	9900000.	0.000
176.220	-0.000877	780936.	-78717.	3.618E-06	741.2899	3.153E+11	4386.8778	9900000.	0.000
178.200	-0.000865	633668.	-70091.	8.061E-06	709.1385	3.153E+11	4326.7763	9900000.	0.000
180.180	-0.000845	503358.	-61622.	1.163E-05	680.6893	3.153E+11	4227.2744	9900000.	0.000
182.160	-0.000819	389617.	-53382.	1.444E-05	655.8575	3.153E+11	4096.4745	9900000.	0.000
184.140	-0.000788	291933.	-45424.	1.658E-05	634.5312	3.153E+11	3941.4488	9900000.	0.000
186.120	-0.000754	209699.	-37791.	1.815E-05	616.5779	3.153E+11	3768.2713	9900000.	0.000
188.100	-0.000716	142237.	-30515.	1.926E-05	601.8496	3.153E+11	3582.0549	9900000.	0.000
190.080	-0.000677	88817.	-23615.	1.998E-05	590.1869	3.153E+11	3386.9944	9900000.	0.000
192.060	-0.000637	48675.	-17108.	2.041E-05	581.4231	3.153E+11	3186.4115	9900000.	0.000
194.040	-0.000597	21024.	-11000.	2.063E-05	575.3864	3.153E+11	2982.8020	9900000.	0.000
196.020	-0.000556	5066.7634	-5297.0335	2.071E-05	571.9026	3.153E+11	2777.8853	9900000.	0.000
198.000	-0.000515	0.000	0.000	2.073E-05	570.7964	3.153E+11	2572.6536	4950000.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = 0.1984071 inches
Computed slope at pile head = -0.0026463 radians
Maximum bending moment = 4952015. inch-lbs
Maximum shear force = -143374. lbs
Depth of maximum bending moment = 138.6000000 inches below pile head

Depth of maximum shear force = 156.4200000 inches below pile head
Number of iterations = 6
Number of zero deflection points = 1

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head = 22000.000 lbs
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 368000.000 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0335	-1455964.	22000.	0.000	1069.8848	1.520E+11	0.000	0.000	0.000
1.980	0.0335	-1412397.	22000.	-1.868E-05	1053.4489	1.520E+11	0.000	0.000	0.000
3.960	0.0335	-1368817.	22000.	-3.679E-05	1037.0080	1.520E+11	0.000	0.000	0.000
5.940	0.0334	-1325223.	22000.	-5.433E-05	1020.5621	1.520E+11	0.000	0.000	0.000
7.920	0.0332	-1281617.	22000.	-7.131E-05	1004.1115	1.520E+11	0.000	0.000	0.000
9.900	0.0331	-1237999.	22000.	-8.771E-05	987.6564	1.520E+11	0.000	0.000	0.000
11.880	0.0329	-1194370.	22000.	-0.000104	971.1968	1.520E+11	0.000	0.000	0.000
13.860	0.0327	-1150728.	22000.	-0.000119	954.7329	1.520E+11	0.000	0.000	0.000
15.840	0.0324	-1107076.	22000.	-0.000134	938.2649	1.520E+11	0.000	0.000	0.000
17.820	0.0321	-1063414.	22000.	-0.000148	921.7929	1.520E+11	0.000	0.000	0.000
19.800	0.0318	-1019741.	22000.	-0.000161	905.3171	1.520E+11	0.000	0.000	0.000
21.780	0.0315	-976059.	22000.	-0.000174	888.8377	1.520E+11	0.000	0.000	0.000
23.760	0.0312	-932367.	22000.	-0.000187	872.3548	1.520E+11	0.000	0.000	0.000
25.740	0.0308	-888667.	22000.	-0.000199	855.8686	1.520E+11	0.000	0.000	0.000
27.720	0.0304	-844958.	22000.	-0.000210	839.3791	1.520E+11	0.000	0.000	0.000
29.700	0.0299	-801241.	22000.	-0.000221	822.8867	1.520E+11	0.000	0.000	0.000
31.680	0.0295	-757517.	22000.	-0.000231	806.3913	1.520E+11	0.000	0.000	0.000
33.660	0.0290	-713785.	22000.	-0.000240	789.8933	1.520E+11	0.000	0.000	0.000
35.640	0.0285	-670047.	22000.	-0.000249	773.3927	1.520E+11	0.000	0.000	0.000
37.620	0.0280	-626302.	22000.	-0.000258	756.8897	1.520E+11	0.000	0.000	0.000
39.600	0.0275	-582551.	22000.	-0.000266	740.3845	1.520E+11	0.000	0.000	0.000
41.580	0.0270	-538795.	22000.	-0.000273	723.8771	1.520E+11	0.000	0.000	0.000
43.560	0.0264	-495033.	22000.	-0.000280	707.3679	1.520E+11	0.000	0.000	0.000
45.540	0.0259	-451267.	22000.	-0.000286	690.8569	1.520E+11	0.000	0.000	0.000
47.520	0.0253	-407497.	22000.	-0.000291	674.3442	1.520E+11	0.000	0.000	0.000
49.500	0.0247	-363723.	22000.	-0.000296	657.8301	1.520E+11	0.000	0.000	0.000
51.480	0.0241	-319945.	22000.	-0.000301	641.3147	1.520E+11	0.000	0.000	0.000
53.460	0.0235	-276164.	22000.	-0.000305	624.7982	1.520E+11	0.000	0.000	0.000
55.440	0.0229	-232381.	22000.	-0.000307	412.2705	3.153E+11	0.000	0.000	0.000
57.420	0.0223	-188597.	22000.	-0.000309	402.7115	3.153E+11	0.000	0.000	0.000
59.400	0.0217	-144811.	22000.	-0.000310	393.1523	3.153E+11	0.000	0.000	0.000
61.380	0.0211	-101025.	22000.	-0.000310	383.5930	3.153E+11	0.000	0.000	0.000

63.360	0.0205	-57239.	22000.	-0.000311	374.0335	3.153E+11	0.000	0.000	0.000
65.340	0.0199	-13452.	22000.	-0.000311	364.4741	3.153E+11	0.000	0.000	0.000
67.320	0.0192	30334.	22000.	-0.000311	368.1597	3.153E+11	0.000	0.000	0.000
69.300	0.0186	74121.	22000.	-0.000311	377.7192	3.153E+11	0.000	0.000	0.000
71.280	0.0180	117907.	22000.	-0.000310	387.2786	3.153E+11	0.000	0.000	0.000
73.260	0.0174	161693.	22000.	-0.000309	396.8379	3.153E+11	0.000	0.000	0.000
75.240	0.0168	205478.	22000.	-0.000308	406.3970	3.153E+11	0.000	0.000	0.000
77.220	0.0162	249262.	22000.	-0.000307	415.9559	3.153E+11	0.000	0.000	0.000
79.200	0.0156	293045.	22000.	-0.000305	425.5145	3.153E+11	0.000	0.000	0.000
81.180	0.0150	336826.	22000.	-0.000303	435.0729	3.153E+11	0.000	0.000	0.000
83.160	0.0144	380606.	22000.	-0.000301	444.6309	3.153E+11	0.000	0.000	0.000
85.140	0.0138	424385.	22000.	-0.000298	454.1886	3.153E+11	0.000	0.000	0.000
87.120	0.0132	468161.	22000.	-0.000295	463.7458	3.153E+11	0.000	0.000	0.000
89.100	0.0126	511935.	22000.	-0.000292	473.3026	3.153E+11	0.000	0.000	0.000
91.080	0.0120	555707.	22000.	-0.000289	482.8588	3.153E+11	0.000	0.000	0.000
93.060	0.0115	599476.	22000.	-0.000285	492.4145	3.153E+11	0.000	0.000	0.000
95.040	0.0109	643243.	22000.	-0.000281	501.9696	3.153E+11	0.000	0.000	0.000
97.020	0.0104	687006.	22000.	-0.000277	511.5240	3.153E+11	0.000	0.000	0.000
99.000	0.009809	730767.	22000.	-0.000273	521.0778	3.153E+11	0.000	0.000	0.000
100.980	0.009273	774524.	22000.	-0.000268	530.6308	3.153E+11	0.000	0.000	0.000
102.960	0.008747	818277.	22000.	-0.000263	540.1831	3.153E+11	0.000	0.000	0.000
104.940	0.008231	862027.	22000.	-0.000258	549.7345	3.153E+11	0.000	0.000	0.000
106.920	0.007726	905773.	22000.	-0.000252	559.2851	3.153E+11	0.000	0.000	0.000
108.900	0.007233	949515.	22000.	-0.000246	568.8348	3.153E+11	0.000	0.000	0.000
110.880	0.006750	993252.	22000.	-0.000240	578.3835	3.153E+11	0.000	0.000	0.000
112.860	0.006281	1036985.	22000.	-0.000234	587.9312	3.153E+11	0.000	0.000	0.000
114.840	0.005824	1080713.	22000.	-0.000227	597.4779	3.153E+11	0.000	0.000	0.000
116.820	0.005381	1124436.	22000.	-0.000220	607.0235	3.153E+11	0.000	0.000	0.000
118.800	0.004951	1168154.	22000.	-0.000213	616.5680	3.153E+11	0.000	0.000	0.000
120.780	0.004537	1211867.	22000.	-0.000206	626.1114	3.153E+11	0.000	0.000	0.000
122.760	0.004137	1255574.	22000.	-0.000198	635.6535	3.153E+11	0.000	0.000	0.000
124.740	0.003753	1299275.	22000.	-0.000190	645.1943	3.153E+11	0.000	0.000	0.000
126.720	0.003385	1342971.	22000.	-0.000182	654.7339	3.153E+11	0.000	0.000	0.000
128.700	0.003033	1386660.	22000.	-0.000173	664.2721	3.153E+11	0.000	0.000	0.000
130.680	0.002699	1430343.	22000.	-0.000164	673.8090	3.153E+11	0.000	0.000	0.000
132.660	0.002383	1474019.	22000.	-0.000155	683.3444	3.153E+11	0.000	0.000	0.000
134.640	0.002085	1517689.	22000.	-0.000146	692.8783	3.153E+11	0.000	0.000	0.000
136.620	0.001806	1561352.	22000.	-0.000136	702.4107	3.153E+11	0.000	0.000	0.000
138.600	0.001547	1605007.	14344.	-0.000126	711.9416	3.153E+11	-7733.3210	9900000.	0.000
140.580	0.001307	1618338.	218.3493	-0.000116	714.8519	3.153E+11	-6535.0254	9900000.	0.000
142.560	0.001087	1606041.	-11634.	-0.000106	712.1672	3.153E+11	-5437.3553	9900000.	0.000
144.540	0.000888	1572420.	-21412.	-9.585E-05	704.8272	3.153E+11	-4439.5463	9900000.	0.000
146.520	0.000708	1521387.	-29312.	-8.614E-05	693.6857	3.153E+11	-3539.5078	9900000.	0.000
148.500	0.000547	1456471.	-35523.	-7.678E-05	679.5133	3.153E+11	-2734.0666	9900000.	0.000
150.480	0.000404	1380830.	-40228.	-6.787E-05	662.9993	3.153E+11	-2019.1865	9900000.	0.000
152.460	0.000278	1297266.	-43604.	-5.946E-05	644.7557	3.153E+11	-1390.1642	9900000.	0.000
154.440	0.000168	1208247.	-45813.	-5.160E-05	625.3210	3.153E+11	-841.8037	9900000.	0.000
156.420	7.371E-05	1115921.	-47011.	-4.430E-05	605.1646	3.153E+11	-368.5701	9900000.	0.000
158.400	-7.055E-06	1022146.	-47341.	-3.758E-05	584.6915	3.153E+11	35.2774	9900000.	0.000
160.380	-7.511E-05	928504.	-46935.	-3.146E-05	564.2477	3.153E+11	375.5694	9900000.	0.000
162.360	-0.000132	836330.	-45911.	-2.591E-05	544.1244	3.153E+11	658.1287	9900000.	0.000
164.340	-0.000178	746733.	-44380.	-2.094E-05	524.5636	3.153E+11	888.6862	9900000.	0.000
166.320	-0.000215	660616.	-42438.	-1.652E-05	505.7626	3.153E+11	1072.8131	9900000.	0.000
168.300	-0.000243	578702.	-40172.	-1.263E-05	487.8792	3.153E+11	1215.8640	9900000.	0.000
170.280	-0.000265	501552.	-37659.	-9.240E-06	471.0359	3.153E+11	1322.9320	9900000.	0.000

172.260	-0.000280	429587.	-34964.	-6.316E-06	455.3243	3.153E+11	1398.8144	9900000.	0.000
174.240	-0.000290	363103.	-32146.	-3.827E-06	440.8096	3.153E+11	1447.9858	9900000.	0.000
176.220	-0.000295	302294.	-29253.	-1.737E-06	427.5339	3.153E+11	1474.5800	9900000.	0.000
178.200	-0.000296	247265.	-26325.	-1.119E-08	415.5199	3.153E+11	1482.3780	9900000.	0.000
180.180	-0.000295	198046.	-23398.	1.387E-06	404.7745	3.153E+11	1474.8015	9900000.	0.000
182.160	-0.000291	154608.	-20497.	2.495E-06	395.2911	3.153E+11	1454.9109	9900000.	0.000
184.140	-0.000285	116873.	-17646.	3.347E-06	387.0529	3.153E+11	1425.4069	9900000.	0.000
186.120	-0.000278	84726.	-14860.	3.980E-06	380.0345	3.153E+11	1388.6360	9900000.	0.000
188.100	-0.000269	58022.	-12152.	4.429E-06	374.2046	3.153E+11	1346.5969	9900000.	0.000
190.080	-0.000260	36598.	-9530.8875	4.726E-06	369.5272	3.153E+11	1300.9501	9900000.	0.000
192.060	-0.000251	20273.	-7002.4494	4.904E-06	365.9632	3.153E+11	1253.0277	9900000.	0.000
194.040	-0.000241	8860.9779	-4570.1456	4.996E-06	363.4717	3.153E+11	1203.8448	9900000.	0.000
196.020	-0.000231	2168.2058	-2235.7695	5.030E-06	362.0105	3.153E+11	1154.1109	9900000.	0.000
198.000	-0.000221	0.000	0.000	5.037E-06	361.5372	3.153E+11	1104.2421	4950000.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection	=	0.0335327 inches
Computed slope at pile head	=	0.000000 radians
Maximum bending moment	=	1618338. inch-lbs
Maximum shear force	=	-47341. lbs
Depth of maximum bending moment	=	140.5800000 inches below pile head
Depth of maximum shear force	=	158.4000000 inches below pile head
Number of iterations	=	6
Number of zero deflection points	=	1

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-head Rotation radians

1	1	V =	15000.	M =	2760000.	581000.	0.19840709	4952015.	-143374.	-0.00264629
2	2	V =	22000.	S =	0.000	368000.	0.03353270	1618338.	-47341.	0.00000000

The analysis ended normally.

Bridge 238 - Bent 1 - Boring B2-A

Required tip resistance

q_{req} = required tip resistance (rounded up to the nearest 10 ksf or 5 tsf)

$$= \frac{R_{req} - \varphi_{qs} R_{sd}}{\frac{A_T}{\varphi_{tip}}} \leq q_p$$

R_{req}		734	kips	Required factored geotechnical resistance
$\varphi_{qs,\ rock}$		0.55		side resistance factor, in Rock
$R_{sd,\ rock}$		0	kips	nominal side resistance, in Rock
$\varphi_{qs,\ IGM}$		0		side resistance factor, in IGM
$R_{sd,\ IGM}$		0	kips	nominal side resistance, in IGM
$\varphi_{qs} R_{sd}$		0	kips	factored developed side resistance
A_T		6.30	ft^2	Area of drilled pier tip (smaller than shaft diameter if rock sock
φ_{tip}		0.5		tip resistance factor
q_{req}		233	ksf	required tip resistance
	=	240	ksf	required tip resistance rounded to the nearest 10 ksf
	=	120	tsf	required tip resistance rounded in tsf
q_p		278	tsf	estimated nominal tip resistance

Required Resistance

R_{req} = required resistance

$$= P_r + y_{DL}(W_T - W_{Soil/Rock}) - y_{WA} W_{Water}$$

P_r		725	kips	Maximum factored axial load
y_{DL}		1.25		Factor for Permanent Dead loads from AASHTO Table 3.4.1-2
W_T		17	kips	Unfactored Weight of Drilled Pier and Column
	Pier Diameter	3	ft	
	Pier Length	12	ft	
	Column Diameter	2.5	ft	
	Column Length	4.5	ft	
	Weight of Concrete	0.155	$kips/ft^3$	
$W_{Soil/Rock}$		5	kips	Unfactored Weight of Soil/Rock that will be displaced below the Design Scour Elevation
	Pier Diameter	3	ft	
	Pier Length - Soil	0	ft	Pier Length in Soil Below the Design Scour Elevation
				DSE: 666 Bottom of Soil: 666
	Unit Weight - Soil	0.12	$kips/ft^3$	
	Pier Length - IGM	0	ft	Pier Length in IGM Below the Design Scour Elevation
				Top of IGM: 666 Bottom of IGM: 666
	Unit Weight - IGM	0.13	$kips/ft^3$	
	Pier Length - Rock	5	ft	Pier Length in Rock Below the Design Scour Elevation
				Top of Rock: 666 Bottom of Rock: 661
	Unit Weight - Rock	0.15	$kips/ft^3$	
y_{WA}		1		Factor for Water Loads from AASHTO Table 3.4.1-1
W_{water}		5	kips	Unfactored Weight of Water Displaced
	Unit Weight - Water	0.0624	$kips/ft^3$	

APPENDIX B-4 – BENT 2, BORING B2-B

BORING B2-B WITH RELEVANT ELEVATIONS
AXIAL CALCULATIONS
L-PILE ANALYSES
REQUIRED TIP RESISTANCE CALCULATIONS

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 17BP.7.R.37	**TIP** 17BP.7.R.37	**COUNTY** GUILFORD	**GEOLOGIST** Bartlett, T.R.	
SITE DESCRIPTION Bridge Number 238 on State Route 1005 (Alamance Road) over Little Alamance Creek				**GROUND WTR (ft)**
BORING NO. B2-B	**STATION** 12+86	**OFFSET** 9 ft RT	**ALIGNMENT** L	**0 HR.** N/A
COLLAR ELEV. 684.4 ft	**TOTAL DEPTH** 22.2 ft	**NORTHING** 829,356	**EASTING** 1,782,628	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TER255 DIEDRICH D-50 77% 07/15/2011		**DRILL METHOD** Mud Rotary		**HAMMER TYPE** Automatic
DRILLER Duggins, W.T.	**START DATE** 06/07/12	**COMP. DATE** 06/07/12	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
685										
										684.4 ROADWAY SURFACE 0.0
										683.4 Asphalt (1.0 ft) 1.0
										682.8 Concrete (0.6 ft) 1.6
										ROADWAY EMBANKMENT
680	680.9	3.5	1	1	2	3		M		Tan, sandy CLAY
						B.O.C. ~ 677.5				677.4 7.0
675	675.9	8.5	1	1	WOH	1		M		Tan, brown and orange, sandy CLAY
						T.O.S. ~ 673				672.4 12.0
670	670.9	13.5	WOH	WOH	WOH	WOH 0				No sample recovery
										666.4 18.0
665	665.9	18.5	16	18	18	Scour ~ 666				**RESIDUAL** Greenish-gray and White SAND with gravel
	662.2	22.2	60/0			60/0				662.2 22.2
						P.O.F. ~ 658.5				Boring Terminated with Standard Penetration Test Refusal at Elevation 662.2 ft on Crystalline Rock (Metamorphosed Granite)
						TIP ~ 657.2				1) Advanced 2-15/16" tricone carb. bit to 22.2 feet. 2) Used creek water and bentonite as drilling fluid.

NCDOT BORE SINGLE BRIDGE 238 BORINGS.GPJ NC_DOT.GDT 11/8/12

Terracon

Analysis Performed By:	*JPM*
Date of Analysis:	*11/7/2012*
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT TIP RESISTANCE IN SOIL, IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2B*	
Boring Elevation:	*673.00*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	*ft*
Shaft Length:	*16*	*ft (below grade)*	**Tip Elevation:**	*657.00*	*ft MSL*	**Cross-section Area:**	*7.1*	*ft²*
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	*ft*

Type of Material at the Tip:	**Rock**

f_c': concrete compressive strength =	**4.50**	ksi

For Soil Section 10.8.3.5.2c, *2010 AASHTO LRFD Bridge Design Specifications*

Cohesionless Soils: $N_{60} \le 50$, $q_p = 1.2*N_{60}$ Equation 10.8.3.5.2c-1, *2010 AASHTO LRFD Bridge Design Specifications*

Cohesive Soils: $N_c = 6(1+0.2(Z/D)) \le 9$ $q_p = N_c * S_u \le 80$ where Z= penetration of shaft in bearing layer

S_u = ksf

Z = ft

N_c =

Cohesionless Soils: **Unit Tip Resistance in Soil, q_p =** (q_p is limited to a maximum of 60 ksf)

Cohesive Soils: **Unit Tip Resistance in Soil, q_p =** (q_p is limited to a maximum of 80 ksf)

For IGM (IGM: Cohesionless soils with blow counts greater than 50 blows/ft, i.e., Very Dense/Hard Soils and PWR)
Section 10.8.3.5.2c, *2010 AASHTO LRFD Bridge Design Specifications*

$$q_p = 0.59 \left[N_{60} \left\{ \frac{p_a}{\sigma'_v} \right\} \right]^{0.8} \sigma'_v$$

Equation 10.8.3.5.2c-2, *2010 AASHTO LRFD Bridge Design Specifications*

Material unit weight at tip =	0.14	kcf		Depth of the tip:	16	ft	Water Level (ft):	0 ft
N: Uncorrected SPT Blow Count at the Tip =	1000	blows/ft		N_{60}* = (ER/60%)N =	100	blows/ft	Type of Hammer:	auto
p_a: atmospheric pressure =	2.12	ksf		σ'_v : vertical effective stress at tip =	0.95	ksf	ER: Hammer Efficiency:	80%

*N_{60} is limited to a maximum of 100 bpf

Unit Tip Resistance in IGM, q_p =

For Rock

$q_p = A + q_u [m_b (A/q_u) + s]^a$ where $A = \sigma'_v + q_u [m_b (\sigma'_v/q_u) + s]^a$

Reference: Turner (2006). *NCHRP Synthesis 360 Rock-Socketed Shafts for Highways Structure Foundations* . Transportation Research Board of National Academies. 136 pp.

q_u: unconfined compressive strength of intact rock — s, a : constant for the Rock Mass — GSI: Geological Strength Index — $GSI^* \approx 18.7e^{(0.0152RQD)}$

m_b: Reduced Value of m_i — $s = \exp^{((GSI-100)/9)}$ — $m_b = m_i (\exp^{((GSI-100)/28)})$ — $a = 1/2 + 1/6(e^{-GSI/15} - e^{-20/3})$ — RQD: Rock Quality Designation

q_u =	1,152	ksf	m_i =	29		RQD =	50	%	A =	70.10	ksf
GSI =	40	s =	1.27E-03	a =	0.51	m_b =	3.40				

* Correlation defined by Truzman et. al. (2011) "Determination of Unit Tip Resistance for Drilled Shafts in Fractured Rocks using the Global Rock Mass Strength", 2011 Pan-Am CGS Geotechnical Conference

Unit Tip Resistance in Rock, q_p = **587** **ksf in Rock** **<** **fc' =** **648** **ksf**

NOTE: Please input the required data where indicated in Blue. When calculating Tip Resistance in Cohesive Soil, please input an Undrained Shear Strength value, Su, into the "Side in Soils (using a-method)" sheet for the bearing layer to generate a tip resistance in cohesive soils output on this sheet. When calculating Tip Resistance in IGM, no data needs to be input onto this sheet other than indicating IGM or Rock as the material at the tip, and the Project Information at the top of the sheet. Please input all soil strata data and shaft information into the "Side in Soils (using B-method)" sheet to generate a tip resistance in IGM output on this sheet. You should always check the input and output values on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/7/2012***
Analysis Reviewed By:	

DRILLED SHAFT SIDE RESISTANCE CALCULATION USING β-METHOD

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*16*	*ft (below grade)*	**Tip Elevation:**	*657*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*			

UNIT SIDE RESISTANCE (q_s) (*Section 10.8.3.5.2b, 2010 AASHTO LRFD Bridge Design Specifications*)

$q_s = \beta\sigma_v'$ ≤ 4.0 ksf for 0.25 ≤ β ≤ 1.2 (Eq. 10.8.3.5.2b-1)

For N_{60} ≤ 15	$\beta = (1.5 - 0.135\,(z)^{0.5})\,N_{60}/15$		
For N_{60} ≥ 15	$\beta = 1.5 - 0.135\,(z)^{0.5}$ (sandy soils)	or	$\beta = 2.0 - 0.06\,(z)^{0.75}$ (gravelly sands and gravels)
N_{60} = (ER/60%)N	N_{60}: SPT blow count corrected for hammer efficiency (blows/ft)		N: uncorrected SPT blow count
σ'_v = vertical effective stress	Hammer efficiency = 80%	Type of Hammer: auto	Water Level (ft): 0 ft

# of Layers:	3	Layer the Tip is located in:	3

Layer	USCS	Soil Type	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	β	Check if 0.25<β<1.2	q_s (ksf)	Check if $q_s \le 4.0$ ksf	Q_{si} (kips)
1	CL	Clay	0	7	0.110	3.5	0.167	0	0					
2	SM	Sand	7	11	0.120	9.0	0.448	36	48	1.10	1.10	0.49	0.49	19
3	Rock	Rock	11	30	0.140	13.5	0.758	1000				Rock		

Total Skin Friction in Soils, $\Sigma(Q_{s,soils})_i$ = 19

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/7/2012***
Analysis Reviewed By:	

DRILLED SHAFT SIDE RESISTANCE CALCULATION USING α-METHOD

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*16*	*ft (below grade)*	**Tip Elevation:**	*657*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*			

UNIT SIDE RESISTANCE (q_s) (*Section 10.8.3.5.1b, 2010 AASHTO LRFD Bridge Design Specifications*)

$q_s = \alpha S_u$ (Eq. 10.8.3.5.1b-1)

For $S_u/p_a \leq 1.5$	$\alpha = 0.55$			
For $1.5 \leq S_u/p_a \leq 2.5$	$\alpha = 0.55 - 0.1(S_u/p_a - 1.5)$	Su = undrained shear strength (ksf)	α = adhesion factor	p_a = atm. pressure = 2.12 ksf
N_{60} = (ER/60%)N	N_{60}: SPT blow count corrected for hammer efficiency (blows/ft)			N: uncorrected SPT blow count
σ'_v = vertical effective stress	Hammer efficiency = 80%	Type of Hammer: auto		Water Level (ft): 0 ft

# of Layers:	3	Layer the Tip is located in:	3

Layer	USCS	Soil Type	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	S_u (ksf)	S_u/p_a	α	q_s (ksf)	Q_{si} (kips)
1	CL	Clay	0	7	0.110	3.5	0.167	0	0	**0.00**	0.00	0.55	0.00	0
2	SM	Sand	7	11	0.120	9.0	0.448	36	48	**0.00**	0.00	0.55	0.00	0
3	Rock	Rock	11	30	0.140	13.5	0.758	1000				Rock		

Total Skin Friction in Soils, $\Sigma(Q_{s,soils})_i$ = 0

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/7/2012***
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR WEAK ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*16*	*ft (below grade)*	**Tip Elevation:**	*657*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	ft

UNIT SIDE RESISTANCE (q_s) for COHESIONLESS IGM SOILS (*Section 10.8.3.5.5, 2010 AASHTO LRFD Bridge Design Specifications*)

$$q_s = \sigma'_v K_o \tan \Phi'$$

Equation referenced from Chapter 11, *Drilled Shafts: Construction Procedures and Design Methods*, FHWA Publication No. FHWA-IF-99-025, O'Neill and Reese, August, 1999.

IGM: Very Hard/Very Dense Cohesionless Soils and PWR with SPT N_{60} > 50 blows-per-foot		N_{60} = (ER/60%)N = SPT N-value corrected for Hammer Efficiency		
$\Phi' = \tan^{-1}((N_{60}/(12.3+20.3(\sigma'_v/p_a)))^{0.34}$	Φ' = effective stress friction angle of IGM	N: Uncorrected SPT N-Value along the shaft		
$K_o = (1-\sin\Phi')OCR^{\sin\Phi'}$	K_o = in-situ coefficient of lateral earth pressure	Hammer Efficiency, ER =	80%	
$OCR = \sigma'_p/\sigma'_v$	σ'_v = vertical effective stress	Type of hammer =	auto	
$\sigma'_p = 0.2N_{60}p_a$	σ'_p = vertical effective stress	Atmospheric Pressure, p_a =	2.12	ksf

# of Layers: 3

Layer	Material	Top of layer (ft)	Bottom of layer (ft)	Unit weight (kcf)	Mid-layer Depth (ft)	σ'_v mid-layer (ksf)	N-value (blows/ft)	N_{60} (blows/ft)	ϕ' (degrees)	σ'_p (ksf)	OCR	K_o	q_s ** (ksf)	Q_s (kips)
1	CL	0	7	0.110	3.5	0.167	0	0				Not IGM		
2	SM	7	11	0.120	9.0	0.448	36	48				Not IGM		
3	Rock	11	30	0.140	13.5	0.758	1000					Not IGM		

*****Unit Side Resistance, qs, has been reduced by 50% of its calculated value based on past local experience in IGM Materials.***

Total Skin Friction in IGM, $\Sigma(Q_{s,IGM})_i$ = 0

NOTE: No data needs to be input on this sheet to calculate skin resistance in IGM. Please input all soil strata information into the "Side in Soils" sheet to generate a skin resistance in IGM output on this sheet. You should always check the input and output information on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	*JPM*
Date of Analysis:	*11/7/2012*
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*16*	*ft (below grade)*	**Tip Elevation:**	*657*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	*0.0*	ft

UNIT SIDE RESISTANCE (q_s) for DRILLED SHAFTS in ROCK (*Section 10.8.3.5.4b, 2010 AASHTO LRFD Bridge Design Specifications*)

$$q_s = 0.65\,\alpha_E\,p_a\,(q_u/p_a)^{0.5} < 7.8\,p_a\,(f_c'/p_a)^{0.5}$$ (Equation 10.8.3.5.4b-1)

For Rock Layer 1

p_a: atmospheric pressure =		2.12	ksf	f_c': concrete compressive strength =		4.50	ksi
q_u: unconfined compressive strength of rock =	1152	ksf		E_m/E_i: reduction factor (determined from Table 10.4.6.5-1) =		0.05	
RQD =	20 %	GSI =	20	α_E = reduction factor to account for jointing in rock =		0.45	

q_s = 14.46 ksf ≤ 24.09 ksf

calculation of qs is OK **use qs = 14.46 ksf for Rock Layer 1**

For Rock Layer 2

p_a: atmospheric pressure =		2.12	ksf	f_c': concrete compressive strength =		4.50	ksi
q_u: unconfined compressive strength of rock =		ksf		E_m/E_i: reduction factor (determined from Table 10.4.6.5-1) =		0.05	
RQD =	%	GSI =		α_E = reduction factor to account for jointing in rock =		0.45	

q_s = 0.00 ksf ≤ 24.09 ksf

calculation of qs is OK **use qs = 0.00 ksf for Rock Layer 2**

AREA OF SHAFT SIDE SURFACE (As) in ROCK

Length in Layer 1 =	5	ft
Length in Layer 2 =		ft
Socket Diameter =	2.8333	ft
Socket perimeter =	8.90	ft

A_s = 44.51 ft^2

Total Skin Friction in Rock, $Q_{s,rock}$ = 643 kips

NOTE: When calculating side resistance in Rock on this sheet, please input the required input data where indicated in Blue. Please input all rock/soil data and shaft information correctly into the "Tip" sheet to generate a Skin Resistance in Rock output on this sheet. You should always check the input and output values on this sheet to ensure accuracy and correctness.

Terracon

Analysis Performed By:	***JPM***
Date of Analysis:	***11/7/2012***
Analysis Reviewed By:	

ANALYSIS OF DRILLED SHAFT RESISTANCE IN IGM OR ROCK

Project Name:	*Bridge 238, Low Impact*		**Project Number:**	*71115060*		**Project Location:**	*Guilford Cnty*	
Shaft Location:	*Interior Bent 2, Right*		**Diameter of Shaft:**	*3*	*ft*	**Boring:**	*B2B*	
Boring Elevation:	*673*	*ft MSL*	**Boring Depth:**	*40*	*ft*	**Shaft Perimeter:**	*9.4*	ft
Shaft Length:	*16*	*ft (below grade)*	**Tip Elevation:**	*657*	*ft MSL*	**Cross-section Area:**	*7.1*	ft^2
Proposed Fill Depth:	*0*	*ft (for End Bents)*	**Tip Diameter:**	*3*	*ft*	**Water Table Depth:**	0.0	ft

Table 10.5.5.2.4-1 Resistance Factors for Geotechnical resistance of Drilled Shafts (2010 AASHTO LRFD Bridge Design Specifications)

Method/Soil/Condition			Resistance Factor
Nominal Axial Compressive Resistance of Single-Drilled Shafts, φ_{stat}	Side resistance in clay	α-method (O'Neill and Reese, 1999)	0.45
	Tip resistance in clay	Total Stress (O'Neill and Reese, 1999)	0.40
	Side resistance in sand	β-method (O'Neill and Reese, 1999)	0.55
	Tip resistance in sand	O'Neill and Reese (1999)	0.50
	Side resistance in IGMs	O'Neill and Reese (1999)	0.60
	Tip resistance in IGMs	O'Neill and Reese (1999)	0.55
	Side resistance in rock	Horvath and Kenney (1979)	0.5
	Tip resistance in rock	O'Neill and Reese (1999)	0.50
Static Load Test (compression), φ_{load}	All Materials		Values in Table 10.5.5.2.3-2, but no greater than 0.70

Nominal Shaft Tip Resistance (R_p)

$R_p = q_p \times A_p$ (Equation 10.8.3.5-2)

q_p = 587 ksf A_p = 6.30 ft^2 **R_p = 3,698 kips** ***(In Rock)***

Nominal Shaft Side Resistance (R_s)

$R_s = q_s \times A_s$ (Equation 10.8.3.5-3)

$R_{s,clay}$ = 0 kips **$R_{s,sand}$ = 19 kips** **$R_{s,IGM}$ = 0 kips** **$R_{s,rock}$ = 643 kips**

Total Nominal Resistance ($R_p + R_s$) = 4,360 kips equivalent to **19,395 kN**

REDUCTION DUE TO GROUP EFFECTS

0.65 ≤ η ≤ 1.00 for 2.5*dia. ≤ Distance Between Shafts ≤ 6*dia. (Section 10.8.3.6.3)

Distance Between Shafts = 18 **feet** **η = 1.00**

FACTORED RESISTANCE OF SINGLE DRILLED SHAFT

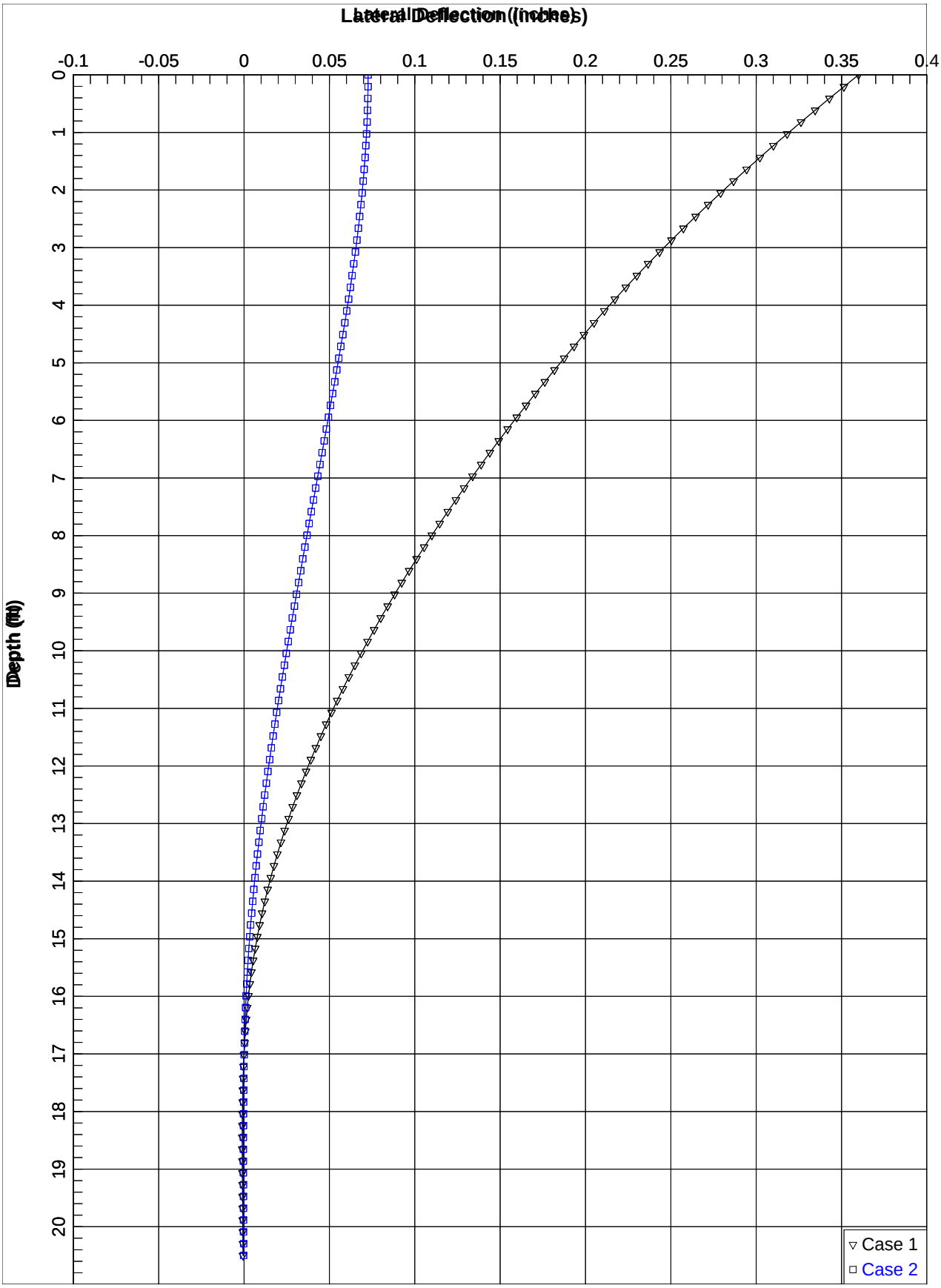
$R_R = \varphi R_n = \varphi_{qp} R_p + \varphi_{qs} R_s$ (Equation 10.8.3.5-1)

φ_{qp} = resistance factor for tip resistance specified in Table 10.5.5.2.4-1

φ_{qs} = resistance factor for shaft side resistance specified in Table 10.5.5.2.4-1

φ_{qp} =	0.50	Rock									
φ_{qs} =	0.45	Clay	φ_{qs} =	0.55	Sand	φ_{qs} =	0.60	IGM	φ_{qs} =	0.55	Rock

Total Factored Resistance, R_R = 2,213 kips


Lateral Deflection (inches)
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1
Case 2

LPile Plus for Windows, Version 6 (6.0.28)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Serial Number of Security Device: 156316250
Company Name Stored in Security Device: WPC, Inc.

Files Used for Analysis

Path to file locations: N:\Projects\2011\71115060\Working Files\Bridge 238\Calculations-Analyses\
Name of input data file: Bridge 238 - B2B.lp6d
Name of output report file: Bridge 238 - B2B.lp6o
Name of plot output file: Bridge 238 - B2B.lp6p
Name of runtime messeage file: Bridge 238 - B2B.lp6r

Date and Time of Analysis

Date: November 8, 2012 Time: 9:05:00

Problem Title

Low Impact Bridge 238 - Guilford County

71115060

KHA

Terracon

Boring B2B - Bent 2

Program Options

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes pile response to lateral loading and will compute nonlinear moment-curvature and nominal moment capacity for selected section types.

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total Number of Sections = 2

Total Pile Length = 20.50 ft

Depth of ground surface below top of pile = 11.50 ft

Pile dimensions used for p-y curve computations defined using 4 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	30.0000000
2	4.500000	30.0000000

3	4.500000	36.0000000
4	20.500000	36.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	4.500 ft
Top Width	=	30.000 in
Bottom Width	=	30.000 in
Top Area	=	706.858347 sq. in
Bottom Area	=	706.858347 sq. in
Moment of Inertia at Top	=	39760.782 in^4
Moment of Inertia at Bottom	=	39760.782 in^4
Elastic Modulus	=	3823676. lbs/in^2

Pile Section No. 2:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	16.000 ft
Top Width	=	36.000 in
Bottom Width	=	36.000 in
Top Area	=	1017.876020 sq. in
Bottom Area	=	1017.876020 sq. in
Moment of Inertia at Top	=	82447.958 in^4
Moment of Inertia at Bottom	=	82447.958 in^4
Elastic Modulus	=	3823676. lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 11.500 ft
Distance from top of pile to bottom of layer = 15.500 ft
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of soil layer = 125.000 lbs/in**3

Layer 2 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 15.500 ft
Distance from top of pile to bottom of layer = 34.000 ft

(Depth of lowest layer extends 13.50 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	11.50	60.00000
2	15.50	60.00000
3	15.50	80.00000
4	34.00	80.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	J pci	kpy psi	Depth of Rock Emass ft	Eff. Unit Wt., pcf	krm	Cohesion Test Type	Friction Test Prop.	Elas. Subgr. Ang., deg.	qu psi	RQD Epsilon 50 percent
1	Sand (Reese, et al.)	--	--	11.500	60.000	--	--	32.000	--	--	--
		125.000	--	--	--	--	--	--			
				15.500	60.000	--	--	32.000	--	--	--
		125.000	--	--	--	--	--	--			
2	Vuggy Limestone	--	--	15.500	80.000	--	--	--	5000.000	--	--
		--	--	--	--	--	--	--			
				34.000	80.000	--	--	--	5000.000	--	--
		--	--	--	--	--	--	--			

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 15000. lbs	M = 2760000. in-lbs	581000.
2	2	V = 22000. lbs	S = 0.0000 in/in	368000.

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Moment-Curvature properties derived from elastic section properties

Pile Section No. 2:

Moment-Curvature properties derived from elastic section properties

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Horizontal shear force at pile head = 15000.000 lbs
Applied moment at pile head = 2760000.000 in-lbs

Axial thrust load on pile head = 581000.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.3600	2760000.	15000.	-0.003518	1863.1739	1.520E+11	0.000	0.000	0.000
2.460	0.3514	2801896.	15000.	-0.003473	1878.9795	1.520E+11	0.000	0.000	0.000
4.920	0.3429	2843728.	15000.	-0.003427	1894.7606	1.520E+11	0.000	0.000	0.000
7.380	0.3345	2885493.	15000.	-0.003381	1910.5169	1.520E+11	0.000	0.000	0.000
9.840	0.3262	2927192.	15000.	-0.003334	1926.2481	1.520E+11	0.000	0.000	0.000
12.300	0.3181	2968823.	15000.	-0.003286	1941.9537	1.520E+11	0.000	0.000	0.000
14.760	0.3101	3010386.	15000.	-0.003238	1957.6334	1.520E+11	0.000	0.000	0.000
17.220	0.3022	3051879.	15000.	-0.003189	1973.2869	1.520E+11	0.000	0.000	0.000
19.680	0.2944	3093301.	15000.	-0.003139	1988.9137	1.520E+11	0.000	0.000	0.000
22.140	0.2867	3134652.	15000.	-0.003089	2004.5135	1.520E+11	0.000	0.000	0.000
24.600	0.2792	3175930.	15000.	-0.003038	2020.0860	1.520E+11	0.000	0.000	0.000
27.060	0.2718	3217135.	15000.	-0.002986	2035.6308	1.520E+11	0.000	0.000	0.000
29.520	0.2645	3258265.	15000.	-0.002934	2051.1475	1.520E+11	0.000	0.000	0.000
31.980	0.2573	3299320.	15000.	-0.002880	2066.6358	1.520E+11	0.000	0.000	0.000
34.440	0.2503	3340299.	15000.	-0.002827	2082.0953	1.520E+11	0.000	0.000	0.000
36.900	0.2434	3381201.	15000.	-0.002772	2097.5257	1.520E+11	0.000	0.000	0.000
39.360	0.2367	3422024.	15000.	-0.002717	2112.9265	1.520E+11	0.000	0.000	0.000
41.820	0.2301	3462768.	15000.	-0.002662	2128.2975	1.520E+11	0.000	0.000	0.000
44.280	0.2236	3503432.	15000.	-0.002605	2143.6383	1.520E+11	0.000	0.000	0.000
46.740	0.2172	3544016.	15000.	-0.002548	2158.9486	1.520E+11	0.000	0.000	0.000
49.200	0.2110	3584517.	15000.	-0.002491	2174.2279	1.520E+11	0.000	0.000	0.000
51.660	0.2050	3624935.	15000.	-0.002432	2189.4759	1.520E+11	0.000	0.000	0.000
54.120	0.1991	3665269.	15000.	-0.002389	1370.9963	3.153E+11	0.000	0.000	0.000
56.580	0.1932	3705563.	15000.	-0.002360	1379.7932	3.153E+11	0.000	0.000	0.000
59.040	0.1875	3745815.	15000.	-0.002331	1388.5810	3.153E+11	0.000	0.000	0.000
61.500	0.1818	3786025.	15000.	-0.002301	1397.3598	3.153E+11	0.000	0.000	0.000
63.960	0.1761	3826194.	15000.	-0.002272	1406.1293	3.153E+11	0.000	0.000	0.000
66.420	0.1706	3866319.	15000.	-0.002242	1414.8895	3.153E+11	0.000	0.000	0.000
68.880	0.1651	3906402.	15000.	-0.002211	1423.6402	3.153E+11	0.000	0.000	0.000
71.340	0.1597	3946440.	15000.	-0.002181	1432.3815	3.153E+11	0.000	0.000	0.000
73.800	0.1544	3986435.	15000.	-0.002150	1441.1131	3.153E+11	0.000	0.000	0.000
76.260	0.1491	4026386.	15000.	-0.002119	1449.8351	3.153E+11	0.000	0.000	0.000
78.720	0.1440	4066291.	15000.	-0.002087	1458.5472	3.153E+11	0.000	0.000	0.000
81.180	0.1389	4106151.	15000.	-0.002055	1467.2495	3.153E+11	0.000	0.000	0.000
83.640	0.1339	4145966.	15000.	-0.002023	1475.9417	3.153E+11	0.000	0.000	0.000
86.100	0.1289	4185734.	15000.	-0.001990	1484.6239	3.153E+11	0.000	0.000	0.000
88.560	0.1241	4225455.	15000.	-0.001958	1493.2958	3.153E+11	0.000	0.000	0.000
91.020	0.1193	4265129.	15000.	-0.001924	1501.9575	3.153E+11	0.000	0.000	0.000
93.480	0.1146	4304756.	15000.	-0.001891	1510.6088	3.153E+11	0.000	0.000	0.000
95.940	0.1100	4344335.	15000.	-0.001857	1519.2496	3.153E+11	0.000	0.000	0.000
98.400	0.1055	4383865.	15000.	-0.001823	1527.8798	3.153E+11	0.000	0.000	0.000
100.860	0.1010	4423346.	15000.	-0.001789	1536.4993	3.153E+11	0.000	0.000	0.000
103.320	0.0967	4462778.	15000.	-0.001754	1545.1081	3.153E+11	0.000	0.000	0.000
105.780	0.0924	4502161.	15000.	-0.001719	1553.7060	3.153E+11	0.000	0.000	0.000
108.240	0.0882	4541493.	15000.	-0.001684	1562.2930	3.153E+11	0.000	0.000	0.000
110.700	0.0841	4580774.	15000.	-0.001648	1570.8689	3.153E+11	0.000	0.000	0.000
113.160	0.0801	4620004.	15000.	-0.001612	1579.4336	3.153E+11	0.000	0.000	0.000
115.620	0.0762	4659183.	15000.	-0.001576	1587.9871	3.153E+11	0.000	0.000	0.000
118.080	0.0723	4698310.	15000.	-0.001540	1596.5293	3.153E+11	0.000	0.000	0.000

120.540	0.0686	4737384.	15000.	-0.001503	1605.0600	3.153E+11	0.000	0.000	0.000
123.000	0.0649	4776406.	15000.	-0.001466	1613.5791	3.153E+11	0.000	0.000	0.000
125.460	0.0614	4815374.	15000.	-0.001428	1622.0867	3.153E+11	0.000	0.000	0.000
127.920	0.0579	4854289.	15000.	-0.001391	1630.5825	3.153E+11	0.000	0.000	0.000
130.380	0.0545	4893149.	15000.	-0.001353	1639.0665	3.153E+11	0.000	0.000	0.000
132.840	0.0513	4931955.	15000.	-0.001314	1647.5386	3.153E+11	0.000	0.000	0.000
135.300	0.0481	4970706.	15000.	-0.001276	1655.9986	3.153E+11	0.000	0.000	0.000
137.760	0.0450	5009401.	15000.	-0.001237	1664.4466	3.153E+11	0.000	0.000	0.000
140.220	0.0420	5048041.	14989.	-0.001197	1672.8824	3.153E+11	-9.0021	527.4086	0.000
142.680	0.0391	5086570.	14954.	-0.001158	1681.2940	3.153E+11	-19.0040	1195.8997	0.000
145.140	0.0363	5124927.	14896.	-0.001118	1689.6681	3.153E+11	-28.9081	1959.4859	0.000
147.600	0.0336	5163052.	14813.	-0.001078	1697.9915	3.153E+11	-38.5881	2825.9624	0.000
150.060	0.0310	5200886.	14708.	-0.001037	1706.2514	3.153E+11	-46.7158	3708.4500	0.000
152.520	0.0285	5238379.	14587.	-0.000997	1714.4368	3.153E+11	-51.7033	4464.9000	0.000
154.980	0.0261	5275500.	14455.	-0.000956	1722.5413	3.153E+11	-55.3654	5221.3500	0.000
157.440	0.0238	5312228.	14316.	-0.000914	1730.5597	3.153E+11	-57.7966	5977.8000	0.000
159.900	0.0216	5348547.	14172.	-0.000873	1738.4888	3.153E+11	-59.0921	6734.2500	0.000
162.360	0.0195	5384449.	14026.	-0.000831	1746.3269	3.153E+11	-59.3483	7490.7000	0.000
164.820	0.0175	5419932.	13881.	-0.000789	1754.0734	3.153E+11	-58.6621	8247.1500	0.000
167.280	0.0156	5454999.	13739.	-0.000746	1761.7292	3.153E+11	-57.1314	9003.6000	0.000
169.740	0.0138	5489659.	13601.	-0.000704	1769.2963	3.153E+11	-54.8547	9760.0500	0.000
172.200	0.0121	5523926.	13470.	-0.000661	1776.7775	3.153E+11	-51.9316	10516.	0.000
174.660	0.0106	5557818.	13346.	-0.000617	1784.1766	3.153E+11	-48.4623	11273.	0.000
177.120	0.009110	5591354.	13232.	-0.000574	1791.4982	3.153E+11	-44.5478	12029.	0.000
179.580	0.007752	5624558.	13127.	-0.000530	1798.7473	3.153E+11	-40.2899	12786.	0.000
182.040	0.006502	5657456.	13034.	-0.000486	1805.9295	3.153E+11	-35.7910	13542.	0.000
184.500	0.005360	5690074.	12951.	-0.000442	1813.0507	3.153E+11	-31.1544	14299.	0.000
186.960	0.004327	5722440.	-13701.	-0.000397	1820.1168	3.153E+11	-21637.	12300000.	0.000
189.420	0.003405	5623801.	-61255.	-0.000353	1798.5820	3.153E+11	-17025.	12300000.	0.000
191.880	0.002590	5422073.	-98126.	-0.000310	1754.5410	3.153E+11	-12952.	12300000.	0.000
194.340	0.001880	5141908.	-125617.	-0.000269	1693.3754	3.153E+11	-9398.8658	12300000.	0.000
196.800	0.001268	4804807.	-144975.	-0.000230	1619.7797	3.153E+11	-6339.7333	12300000.	0.000
199.260	0.000748	4429287.	-157375.	-0.000194	1537.7964	3.153E+11	-3741.7646	12300000.	0.000
201.720	0.000314	4031074.	-163908.	-0.000161	1450.8587	3.153E+11	-1568.9174	12300000.	0.000
204.180	-4.341E-05	3623322.	-165570.	-0.000131	1361.8384	3.153E+11	217.0286	12300000.	0.000
206.640	-0.000331	3216842.	-163268.	-0.000104	1273.0960	3.153E+11	1655.2094	12300000.	0.000
209.100	-0.000557	2820344.	-157807.	-8.082E-05	1186.5326	3.153E+11	2784.6388	12300000.	0.000
211.560	-0.000729	2440665.	-149900.	-6.029E-05	1103.6413	3.153E+11	3643.3725	12300000.	0.000
214.020	-0.000854	2083007.	-140169.	-4.264E-05	1025.5577	3.153E+11	4267.8520	12300000.	0.000
216.480	-0.000938	1751154.	-129148.	-2.768E-05	953.1076	3.153E+11	4692.4051	12300000.	0.000
218.940	-0.000990	1447677.	-117289.	-1.520E-05	886.8527	3.153E+11	4948.8831	12300000.	0.000
221.400	-0.001013	1174134.	-104971.	-4.974E-06	827.1327	3.153E+11	5066.4135	12300000.	0.000
223.860	-0.001014	931236.	-92501.	3.240E-06	774.1035	3.153E+11	5071.2509	12300000.	0.000
226.320	-0.000997	719018.	-80130.	9.679E-06	727.7721	3.153E+11	4986.7086	12300000.	0.000
228.780	-0.000967	536969.	-68052.	1.458E-05	688.0273	3.153E+11	4833.1551	12300000.	0.000
231.240	-0.000926	384163.	-56414.	1.817E-05	654.6667	3.153E+11	4628.0636	12300000.	0.000
233.700	-0.000877	259359.	-45327.	2.068E-05	627.4196	3.153E+11	4386.1002	12300000.	0.000
236.160	-0.000824	161096.	-34865.	2.232E-05	605.9667	3.153E+11	4119.2437	12300000.	0.000
238.620	-0.000767	87758.	-25079.	2.330E-05	589.9558	3.153E+11	3836.9252	12300000.	0.000
241.080	-0.000709	37640.	-15998.	2.378E-05	579.0139	3.153E+11	3546.1837	12300000.	0.000
243.540	-0.000650	8980.4254	-7636.3851	2.397E-05	572.7570	3.153E+11	3251.8296	12300000.	0.000
246.000	-0.000591	0.000	0.000	2.400E-05	570.7964	3.153E+11	2956.6136	6150000.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
The above values of total stress are computed for combined axial stress and do not equal the

actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.3599594	inches
Computed slope at pile head	=	-0.0035180	radians
Maximum bending moment	=	5722440.	inch-lbs
Maximum shear force	=	-165570.	lbs
Depth of maximum bending moment	=	186.9600000	inches below pile head
Depth of maximum shear force	=	204.1800000	inches below pile head
Number of iterations	=	6	
Number of zero deflection points	=	1	

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head	=	22000.000	lbs
Rotation of pile head	=	0.000E+00	radians
Axial load at pile head	=	368000.000	lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0726	-1933241.	22000.	0.000	1249.9404	1.520E+11	0.000	0.000	0.000
2.460	0.0726	-1879106.	22000.	-3.084E-05	1229.5180	1.520E+11	0.000	0.000	0.000
4.920	0.0725	-1824945.	22000.	-6.081E-05	1209.0851	1.520E+11	0.000	0.000	0.000
7.380	0.0723	-1770756.	22000.	-8.990E-05	1188.6422	1.520E+11	0.000	0.000	0.000
9.840	0.0721	-1716542.	22000.	-0.000118	1168.1895	1.520E+11	0.000	0.000	0.000
12.300	0.0717	-1662302.	22000.	-0.000145	1147.7273	1.520E+11	0.000	0.000	0.000
14.760	0.0713	-1608039.	22000.	-0.000172	1127.2560	1.520E+11	0.000	0.000	0.000
17.220	0.0709	-1553751.	22000.	-0.000197	1106.7757	1.520E+11	0.000	0.000	0.000
19.680	0.0704	-1499441.	22000.	-0.000222	1086.2869	1.520E+11	0.000	0.000	0.000
22.140	0.0698	-1445109.	22000.	-0.000246	1065.7897	1.520E+11	0.000	0.000	0.000
24.600	0.0692	-1390756.	22000.	-0.000269	1045.2846	1.520E+11	0.000	0.000	0.000
27.060	0.0685	-1336382.	22000.	-0.000291	1024.7718	1.520E+11	0.000	0.000	0.000
29.520	0.0677	-1281989.	22000.	-0.000312	1004.2516	1.520E+11	0.000	0.000	0.000
31.980	0.0669	-1227577.	22000.	-0.000333	983.7244	1.520E+11	0.000	0.000	0.000
34.440	0.0661	-1173147.	22000.	-0.000352	963.1903	1.520E+11	0.000	0.000	0.000
36.900	0.0652	-1118699.	22000.	-0.000370	942.6498	1.520E+11	0.000	0.000	0.000
39.360	0.0643	-1064236.	22000.	-0.000388	922.1030	1.520E+11	0.000	0.000	0.000
41.820	0.0633	-1009757.	22000.	-0.000405	901.5504	1.520E+11	0.000	0.000	0.000
44.280	0.0623	-955263.	22000.	-0.000421	880.9923	1.520E+11	0.000	0.000	0.000

46.740	0.0612	-900755.	22000.	-0.000436	860.4288	1.520E+11	0.000	0.000	0.000
49.200	0.0601	-846234.	22000.	-0.000450	839.8604	1.520E+11	0.000	0.000	0.000
51.660	0.0590	-791700.	22000.	-0.000463	819.2873	1.520E+11	0.000	0.000	0.000
54.120	0.0578	-737155.	22000.	-0.000472	522.4725	3.153E+11	0.000	0.000	0.000
56.580	0.0567	-682605.	22000.	-0.000478	510.5631	3.153E+11	0.000	0.000	0.000
59.040	0.0555	-628050.	22000.	-0.000483	498.6526	3.153E+11	0.000	0.000	0.000
61.500	0.0543	-573490.	22000.	-0.000488	486.7412	3.153E+11	0.000	0.000	0.000
63.960	0.0531	-518926.	22000.	-0.000492	474.8289	3.153E+11	0.000	0.000	0.000
66.420	0.0519	-464359.	22000.	-0.000496	462.9158	3.153E+11	0.000	0.000	0.000
68.880	0.0507	-409788.	22000.	-0.000499	451.0020	3.153E+11	0.000	0.000	0.000
71.340	0.0494	-355215.	22000.	-0.000502	439.0875	3.153E+11	0.000	0.000	0.000
73.800	0.0482	-300639.	22000.	-0.000505	427.1725	3.153E+11	0.000	0.000	0.000
76.260	0.0469	-246061.	22000.	-0.000507	415.2570	3.153E+11	0.000	0.000	0.000
78.720	0.0457	-191481.	22000.	-0.000509	403.3412	3.153E+11	0.000	0.000	0.000
81.180	0.0444	-136900.	22000.	-0.000510	391.4250	3.153E+11	0.000	0.000	0.000
83.640	0.0432	-82317.	22000.	-0.000511	379.5087	3.153E+11	0.000	0.000	0.000
86.100	0.0419	-27735.	22000.	-0.000511	367.5922	3.153E+11	0.000	0.000	0.000
88.560	0.0407	26848.	22000.	-0.000511	367.3987	3.153E+11	0.000	0.000	0.000
91.020	0.0394	81431.	22000.	-0.000511	379.3151	3.153E+11	0.000	0.000	0.000
93.480	0.0382	136013.	22000.	-0.000510	391.2315	3.153E+11	0.000	0.000	0.000
95.940	0.0369	190594.	22000.	-0.000509	403.1476	3.153E+11	0.000	0.000	0.000
98.400	0.0356	245174.	22000.	-0.000507	415.0635	3.153E+11	0.000	0.000	0.000
100.860	0.0344	299753.	22000.	-0.000505	426.9790	3.153E+11	0.000	0.000	0.000
103.320	0.0332	354329.	22000.	-0.000502	438.8940	3.153E+11	0.000	0.000	0.000
105.780	0.0319	408902.	22000.	-0.000499	450.8085	3.153E+11	0.000	0.000	0.000
108.240	0.0307	463473.	22000.	-0.000496	462.7223	3.153E+11	0.000	0.000	0.000
110.700	0.0295	518040.	22000.	-0.000492	474.6354	3.153E+11	0.000	0.000	0.000
113.160	0.0283	572604.	22000.	-0.000488	486.5478	3.153E+11	0.000	0.000	0.000
115.620	0.0271	627163.	22000.	-0.000483	498.4592	3.153E+11	0.000	0.000	0.000
118.080	0.0259	681719.	22000.	-0.000478	510.3697	3.153E+11	0.000	0.000	0.000
120.540	0.0247	736269.	22000.	-0.000473	522.2791	3.153E+11	0.000	0.000	0.000
123.000	0.0236	790814.	22000.	-0.000467	534.1874	3.153E+11	0.000	0.000	0.000
125.460	0.0224	845354.	22000.	-0.000460	546.0945	3.153E+11	0.000	0.000	0.000
127.920	0.0213	899888.	22000.	-0.000453	558.0002	3.153E+11	0.000	0.000	0.000
130.380	0.0202	954415.	22000.	-0.000446	569.9046	3.153E+11	0.000	0.000	0.000
132.840	0.0191	1008936.	22000.	-0.000439	581.8075	3.153E+11	0.000	0.000	0.000
135.300	0.0181	1063449.	22000.	-0.000430	593.7088	3.153E+11	0.000	0.000	0.000
137.760	0.0170	1117955.	22000.	-0.000422	605.6086	3.153E+11	0.000	0.000	0.000
140.220	0.0160	1172453.	21995.	-0.000413	617.5065	3.153E+11	-4.4340	682.6500	0.000
142.680	0.0150	1226916.	21978.	-0.000404	629.3969	3.153E+11	-8.7596	1439.1000	0.000
145.140	0.0140	1281317.	21952.	-0.000394	641.2737	3.153E+11	-12.4883	2195.5500	0.000
147.600	0.0130	1335634.	21918.	-0.000384	653.1321	3.153E+11	-15.6431	2952.0000	0.000
150.060	0.0121	1389846.	21876.	-0.000373	664.9677	3.153E+11	-18.2482	3708.4500	0.000
152.520	0.0112	1443938.	21828.	-0.000362	676.7771	3.153E+11	-20.3292	4464.9000	0.000
154.980	0.0103	1497897.	21776.	-0.000350	688.5574	3.153E+11	-21.9129	5221.3500	0.000
157.440	0.009476	1551713.	21721.	-0.000339	700.3065	3.153E+11	-23.0274	5977.8000	0.000
159.900	0.008658	1605379.	21664.	-0.000326	712.0227	3.153E+11	-23.7021	6734.2500	0.000
162.360	0.007871	1658890.	21605.	-0.000314	723.7052	3.153E+11	-23.9675	7490.7000	0.000
164.820	0.007116	1712244.	21546.	-0.000300	735.3534	3.153E+11	-23.8555	8247.1500	0.000
167.280	0.006393	1765441.	21488.	-0.000287	746.9675	3.153E+11	-23.3993	9003.6000	0.000
169.740	0.005705	1818485.	21432.	-0.000273	758.5479	3.153E+11	-22.6332	9760.0500	0.000
172.200	0.005051	1871378.	21377.	-0.000258	770.0956	3.153E+11	-21.5928	10516.	0.000
174.660	0.004433	1924128.	21326.	-0.000244	781.6119	3.153E+11	-20.3150	11273.	0.000
177.120	0.003852	1976741.	21277.	-0.000228	793.0984	3.153E+11	-18.8380	12029.	0.000
179.580	0.003309	2029227.	21233.	-0.000213	804.5570	3.153E+11	-17.2009	12786.	0.000

182.040	0.002806	2081593.	21193.	-0.000197	815.9897	3.153E+11	-15.4444	13542.	0.000
184.500	0.002342	2133852.	21157.	-0.000180	827.3987	3.153E+11	-13.6102	14299.	0.000
186.960	0.001919	2186013.	9341.5767	-0.000163	838.7866	3.153E+11	-9592.5978	12300000.	0.000
189.420	0.001537	2180108.	-11913.	-0.000146	837.4974	3.153E+11	-7687.3227	12300000.	0.000
191.880	0.001198	2127668.	-28737.	-0.000130	826.0486	3.153E+11	-5991.2936	12300000.	0.000
194.340	0.000900	2038955.	-41641.	-0.000113	806.6809	3.153E+11	-4499.4774	12300000.	0.000
196.800	0.000641	1922999.	-51116.	-9.787E-05	781.3654	3.153E+11	-3203.3594	12300000.	0.000
199.260	0.000418	1787644.	-57629.	-8.340E-05	751.8147	3.153E+11	-2091.8101	12300000.	0.000
201.720	0.000230	1639617.	-61618.	-7.002E-05	719.4976	3.153E+11	-1151.8384	12300000.	0.000
204.180	7.385E-05	1484608.	-63489.	-5.783E-05	685.6562	3.153E+11	-369.2365	12300000.	0.000
206.640	-5.417E-05	1327355.	-63610.	-4.686E-05	651.3246	3.153E+11	270.8732	12300000.	0.000
209.100	-0.000157	1171731.	-62313.	-3.711E-05	617.3489	3.153E+11	783.5839	12300000.	0.000
211.560	-0.000237	1020841.	-59893.	-2.856E-05	584.4066	3.153E+11	1183.8321	12300000.	0.000
214.020	-0.000297	877108.	-56609.	-2.115E-05	553.0269	3.153E+11	1486.1005	12300000.	0.000
216.480	-0.000341	742361.	-52685.	-1.483E-05	523.6091	3.153E+11	1704.1843	12300000.	0.000
218.940	-0.000370	617923.	-48312.	-9.527E-06	496.4418	3.153E+11	1851.0165	12300000.	0.000
221.400	-0.000388	504682.	-43651.	-5.147E-06	471.7191	3.153E+11	1938.5407	12300000.	0.000
223.860	-0.000396	403168.	-38834.	-1.605E-06	449.5567	3.153E+11	1977.6258	12300000.	0.000
226.320	-0.000396	313620.	-33969.	1.192E-06	430.0065	3.153E+11	1978.0148	12300000.	0.000
228.780	-0.000390	236039.	-29139.	3.337E-06	413.0692	3.153E+11	1948.3027	12300000.	0.000
231.240	-0.000379	170248.	-24411.	4.922E-06	398.7055	3.153E+11	1895.9356	12300000.	0.000
233.700	-0.000365	115928.	-19832.	6.038E-06	386.8465	3.153E+11	1827.2282	12300000.	0.000
236.160	-0.000349	72665.	-15435.	6.774E-06	377.4014	3.153E+11	1747.3941	12300000.	0.000
238.620	-0.000332	39976.	-11243.	7.214E-06	370.2648	3.153E+11	1660.5856	12300000.	0.000
241.080	-0.000314	17337.	-7269.4477	7.437E-06	365.3221	3.153E+11	1569.9401	12300000.	0.000
243.540	-0.000296	4197.3099	-3520.9355	7.521E-06	362.4535	3.153E+11	1477.6307	12300000.	0.000
246.000	-0.000277	0.000	0.000	7.538E-06	361.5372	3.153E+11	1384.9185	6150000.	0.000

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial stress and do not equal the
  actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection             =      0.0726455 inches
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =       2186013. inch-lbs
Maximum shear force              =        -63610. lbs
Depth of maximum bending moment  =    186.9600000 inches below pile head
Depth of maximum shear force     =    206.6400000 inches below pile head
Number of iterations             =              6
Number of zero deflection points =              1
```

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-head Rotation radians
1	1	V = 15000.	M = 2760000.	581000.	0.35995936	5722440.	-165570.	-0.00351797
2	2	V = 22000.	S = 0.000	368000.	0.07264547	2186013.	-63610.	0.00000000

The analysis ended normally.

Bridge 238 - Bent 1 - Boring B2-B

Required tip resistance

q_{req} = required tip resistance (rounded up to the nearest 10 ksf or 5 tsf)

$$= \frac{R_{req} - \varphi_{qs} R_{sd}}{A_T} \leq \frac{}{\varphi_{tip}} q_p$$

R_{req}	733	kips	Required factored geotechnical resistance
$\varphi_{qs,\ rock}$	0.55		side resistance factor, in Rock
$R_{sd,\ rock}$	0	kips	nominal side resistance, in Rock
$\varphi_{qs,\ IGM}$	0.55		side resistance factor, in IGM
$R_{sd,\ IGM}$	0	kips	nominal side resistance, in IGM
$\varphi_{qs}R_{sd}$	0	kips	factored developed side resistance
A_T	6.30	ft^2	Area of drilled pier tip (smaller than shaft diameter if rock socket
φ_{tip}	0.5		tip resistance factor
q_{req}	233	ksf	required tip resistance
=	240	ksf	required tip resistance rounded to the nearest 10 ksf
=	120	tsf	required tip resistance rounded in tsf
q_p	293	tsf	estimated nominal tip resistance

Required Resistance

R_{req} = required resistance

$$= P_r + y_{DL}(W_T - W_{Soil/Rock}) - y_{WA}W_{Water}$$

P_r	725	kips		Maximum factored axial load
y_{DL}	1.25			Factor for Permanent Dead loads from AASHTO Table 3.4.1-2
W_T	21	kips		Unfactored Weight of Drilled Pier and Column
	Pier Diameter	3	ft	
	Pier Length	16	ft	
	Column Diameter	2.5	ft	
	Column Length	4.5	ft	
	Weight of Concrete	0.155	$kips/ft^3$	
$W_{Soil/Rock}$	9	kips		Unfactored Weight of Soil/Rock that will be displaced below the Design Scour Elevation
	Pier Diameter	3	ft	
	Pier Length - Soil	4	ft	Pier Length in Soil Below the Design Scour Elevation
				DSE: 666 Bottom of Soil: 662
	Unit Weight - Soil	0.12	$kips/ft^3$	
	Pier Length - IGM	0	ft	Pier Length in IGM Below the Design Scour Elevation
				Top of IGM: 662 Bottom of IGM: 662
	Unit Weight - IGM	0.13	$kips/ft^3$	
	Pier Length - Rock	5	ft	Pier Length in Rock Below the Design Scour Elevation
				Top of Rock: 662 Bottom of Rock: 657
	Unit Weight - Rock	0.15	$kips/ft^3$	
y_{WA}	1			Factor for Water Loads from AASHTO Table 3.4.1-1
W_{water}	7	kips		Unfactored Weight of Water Displaced
	Unit Weight - Water	0.0624	$kips/ft^3$	

APPENDIX B-5 – PIER PAY ITEMS CALCULATIONS

Bent No. 1

Weathered Rock

Boring	Pier	Top Elevation	Bottom Elevation	Length	Comment
B1-A	Left - 1	668.1	663.6	4.5	
B1-A	Left - 2	668.1	663.6	4.5	
B1-B	Right - 1	667	663.5	3.5	
B1-B	Right - 2	667	663.5	3.5	
				0	
				0	
			Total Weathered Rock:	16	

Rock

Boring	Pier	Top Elevation	Bottom Elevation	Length	Comment
B1-A	Left - 1	663.6	659.6	4	
B1-A	Left - 2	663.6	659.6	4	
B1-B	Right - 1	663.5	659	4.5	
B1-B	Right - 2	663.5	659	4.5	
				0	
				0	
			Total Rock:	17	

Total Driled Shaft not in Soil for Bent No. 1: 25

Bent No. 2

Weathered Rock

Boring	Pier	Top Elevation	Bottom Elevation	Length	Comment
B2-A	Left - 1			0	
B2-A	Left - 2			0	
B2-B	Right - 1			0	
B2-B	Right - 2			0	
				0	
				0	
			Total Weathered Rock:	0	

Rock

Boring	Pier	Top Elevation	Bottom Elevation	Length	Comment
B2-A	Left - 1	666	661	5	
B2-A	Left - 2	666	661	5	
B2-B	Right - 1	662.2	657.2	5	
B2-B	Right - 2	662.2	657.2	5	
				0	
				0	
			Total Rock:	20	

Total Driled Shaft not in Soil for Bent No. 2: 20

STABILIZATION REQUIREMENTS:

Stabilization for this project shall comply with the time frame guidelines as specified by the NCG-010000 general construction permit effective August 3, 2011 issued by the North Carolina Department of Environment and Natural Resources Division of Water Quality. Temporary or permanent ground cover stabilization shall occur within 7 calendar days from the last land-disturbing activity, with the following exceptions in which temporary or permanent ground cover shall be provided in 14 calendar days from the last land-disturbing activity:

- Slopes between 2:1 and 3:1, with a slope length of 10 ft. or less
- Slopes 3:1 or flatter, with a slope of length of 50 ft. or less
- Slopes 4:1 or flatter

The stabilization timeframe for High Quality Water (HQW) Zones shall be 7 calendar days with no exceptions for slope grades or lengths. High Quality Water Zones (HQW) Zones are defined by North Carolina Administrative Code 15A NCAC 04A.0105 (25). Temporary and permanent ground cover stabilization shall be achieved in accordance with the provisions in this contract and as directed.

SEEDING AND MULCHING: (East)

The kinds of seed and fertilizer, and the rates of application of seed, fertilizer, and limestone, shall be as stated below. During periods of overlapping dates, the kind of seed to be used shall be determined. All rates are in pounds per acre.

All Roadway Areas

March 1 - August 31		**September 1 - February 28**	
50#	Tall Fescue	50#	Tall Fescue
10#	Centipede	10#	Centipede
25#	Bermudagrass (hulled)	35#	Bermudagrass (unhulled)
500#	Fertilizer	500#	Fertilizer
4000#	Limestone	4000#	Limestone

Waste and Borrow Locations

March 1 – August 31		**September 1 - February 28**	
75#	Tall Fescue	75#	Tall Fescue
25#	Bermudagrass (hulled)	35#	Bermudagrass (unhulled)
500#	Fertilizer	500#	Fertilizer
4000#	Limestone	4000#	Limestone

Note: 50# of Bahiagrass may be substituted for either Centipede or Bermudagrass only upon Engineer's request.

Approved Tall Fescue Cultivars

2nd Millennium	Duster	Magellan	Rendition
Avenger	Endeavor	Masterpiece	Scorpion
Barlexas	Escalade	Matador	Shelby
Barlexas II	Falcon II, III, IV & V	Matador GT	Signia
Barrera	Fidelity	Millennium	Silverstar
Barrington	Finesse II	Montauk	Southern Choice II
Biltmore	Firebird	Mustang 3	Stetson
Bingo	Focus	Olympic Gold	Tarheel
Bravo	Grande II	Padre	Titan Ltd
Cayenne	Greenkeeper	Paraiso	Titanium
Chapel Hill	Greystone	Picasso	Tomahawk
Chesapeake	Inferno	Piedmont	Tacer
Constitution	Justice	Pure Gold	Trooper
Chipper	Jaguar 3	Prospect	Turbo
Coronado	Kalahari	Quest	Ultimate
Coyote	Kentucky 31	Rebel Exeda	Watchdog
Davinci	Kitty Hawk	Rebel Sentry	Wolfpack
Dynasty	Kitty Hawk 2000	Regiment II	
Dominion	Lexington	Rembrandt	

On cut and fill slopes 2:1 or steeper Centipede shall be applied at the rate of 5 pounds per acre and add 20# of Sericea Lespedeza from January 1 - December 31.

Fertilizer shall be 10-20-20 analysis. A different analysis of fertilizer may be used provided the 1-2-2 ratio is maintained and the rate of application adjusted to provide the same amount of plant food as a 10-20-20 analysis and as directed.

TEMPORARY SEEDING:

Fertilizer shall be the same analysis as specified for *Seeding and Mulching* and applied at the rate of 400 pounds and seeded at the rate of 50 pounds per acre. Sweet Sudan Grass, German Millet or Browntop Millet shall be used in summer months and Rye Grain during the remainder of the year. The Engineer will determine the exact dates for using each kind of seed.

FERTILIZER TOPDRESSING:

Fertilizer used for topdressing on all roadway areas except slopes 2:1 and steeper shall be 10-20-20 grade and shall be applied at the rate of 500 pounds per acre. A different analysis of fertilizer may be used provided the 1-2-2 ratio is maintained and the rate of application adjusted to provide the same amount of plant food as 10-20-20 analysis and as directed.

Fertilizer used for topdressing on slopes 2:1 and steeper and waste and borrow areas shall be 16-8-8 grade and shall be applied at the rate of 500 pounds per acre. A different analysis of fertilizer may be used provided the 2-1-1 ratio is maintained and the rate of application adjusted to provide the same amount of plant food as 16-8-8 analysis and as directed.

SUPPLEMENTAL SEEDING:

The kinds of seed and proportions shall be the same as specified for *Seeding and Mulching*, with the exception that no centipede seed will be used in the seed mix for supplemental seeding. The rate of application for supplemental seeding may vary from 25# to 75# per acre. The actual rate per acre will be determined prior to the time of topdressing and the Contractor will be notified in writing of the rate per acre, total quantity needed, and areas on which to apply the supplemental seed. Minimum tillage equipment, consisting of a sod seeder shall be used for incorporating seed into the soil as to prevent disturbance of existing vegetation. A clodbuster (ball and chain) may be used where degree of slope prevents the use of a sod seeder.

MOWING:

The minimum mowing height on this project shall be 4 inches.

STABILIZATION REQUIREMENTS:

Stabilization for this project shall comply with the time frame guidelines as specified by the NCG-010000 general construction permit effective August 3, 2011 issued by the North Carolina Department of Environment and Natural Resources Division of Water Quality. Temporary or permanent ground cover stabilization shall occur within 7 calendar days from the last land-disturbing activity, with the following exceptions in which temporary or permanent ground cover shall be provided in 14 calendar days from the last land-disturbing activity:

- Slopes between 2:1 and 3:1, with a slope length of 10 ft. or less
- Slopes 3:1 or flatter, with a slope of length of 50 ft. or less
- Slopes 4:1 or flatter

The stabilization timeframe for High Quality Water (HQW) Zones shall be 7 calendar days with no exceptions for slope grades or lengths. High Quality Water Zones (HQW) Zones are defined by North Carolina Administrative Code 15A NCAC 04A.0105 (25). Temporary and permanent ground cover stabilization shall be achieved in accordance with the provisions in this contract and as directed.

NATIVE GRASS SEEDING AND MULCHING: (West)

Native Grass Seeding and Mulching shall be performed on the disturbed areas of wetlands and riparian areas, and adjacent to Stream Relocation and/or trout stream construction within a 50 foot zone on both sides of the stream or depression, measured from top of stream bank or center of depression. The stream bank of the stream relocation shall be seeded by a method that does not alter the typical cross section of the stream bank. Native Grass Seeding and Mulching shall also be performed in the permanent soil reinforcement mat section of preformed scour holes, and in other areas as directed.

The kinds of seed and fertilizer, and the rates of application of seed, fertilizer, and limestone, shall be as stated below. During periods of overlapping dates, the kind of seed to be used shall be determined. All rates are in pounds per acre.

August 1 - June 1		**May 1 – September 1**	
18#	Creeping Red Fescue	18#	Creeping Red Fescue
8#	Big Bluestem	8#	Big Bluestem
6#	Indiangrass	6#	Indiangrass
4#	Switchgrass	4#	Switchgrass
35#	Rye Grain	25#	German or Browntop Millet
500#	Fertilizer	500#	Fertilizer
4000#	Limestone	4000	Limestone

Approved Creeping Red Fescue Cultivars:

Aberdeen Boreal Epic Cindy Lou

Fertilizer shall be 10-20-20 analysis. A different analysis of fertilizer may be used provided the 1-2-2 ratio is maintained and the rate of application adjusted to provide the same amount of plant food as a 10-20-20 analysis and as directed.

Temporary Seeding

Fertilizer shall be the same analysis as specified for *Seeding and Mulching* and applied at the rate of 400 pounds and seeded at the rate of 50 pounds per acre. German Millet or Browntop Millet shall be used in summer months and rye grain during the remainder of the year. The Engineer will determine the exact dates for using each kind of seed.

Fertilizer Topdressing

Fertilizer used for topdressing shall be 16-8-8 grade and shall be applied at the rate of 500 pounds per acre. A different analysis of fertilizer may be used provided the 2-1-1 ratio is maintained and the rate of application adjusted to provide the same amount of plant food as 16-8-8 analysis and as directed.

Supplemental Seeding

The kinds of seed and proportions shall be the same as specified for *Seeding and Mulching*, and the rate of application may vary from 25# to 75# per acre. The actual rate per acre will be determined prior to the time of topdressing and the Contractor will be notified in writing of the rate per acre, total quantity needed, and areas on which to apply the supplemental seed. Minimum tillage equipment, consisting of a sod seeder shall be used for incorporating seed into the soil as to prevent disturbance of existing vegetation. A clodbuster (ball and chain) may be used where degree of slope prevents the use of a sod seeder.

Mowing

The minimum mowing height shall be 6 inches.

Measurement and Payment

Native Grass *Seeding and Mulching* will be measured and paid for in accordance with Article 1660-8 of the *Standard Specifications*.

REFORESTATION:

Description

Reforestation will be planted within interchanges and along the outside borders of the road, and in other areas as directed. *Reforestation* is not shown on the plan sheets. See the Reforestation Detail Sheet.

All non-maintained riparian buffers impacted by the placement of temporary fill or clearing activities shall be restored to the preconstruction contours and revegetated with native woody species.

The entire *Reforestation* operation shall comply with the requirements of Section 1670 of the *Standard Specifications*.

Materials

Reforestation shall be bare root seedlings 12"-18" tall.

Construction Methods

Reforestation shall be shall be planted as soon as practical following permanent S*eeding and Mulching*. The seedlings shall be planted in a 16-foot wide swath adjacent to mowing pattern line, or as directed.

Root dip: The roots of reforestation seedlings shall be coated with a slurry of water, and either a fine clay (kaolin) or a superabsorbent that is designated as a bare root dip. The type, mixture ratio, method of application, and the time of application shall be submitted to the Engineer for approval.

With the approval of the Engineer, seedlings may be coated before delivery to the job or at the time of planting, but at no time shall the roots of the seedlings be allowed to dry out. The roots shall be moistened immediately prior to planting.

Seasonal Limitations: *Reforestation* shall be planted from November 15 through March 15.

Measurement and Payment

Reforestation will be measured and paid for in accordance with Article 1670-17 of the *Standard Specifications*.

RESPONSE FOR EROSION CONTROL:

Description

Furnish the labor, materials, tools and equipment necessary to move personnel, equipment, and supplies to the project necessary for the pursuit of any or all of the following work as shown herein, by an approved subcontractor.

Section	Erosion Control Item	Unit
1605	Temporary Silt Fence	LF
SP	Special Sediment Control Fence	LF/TON
1615	Temporary Mulching	ACR
1620	Seed - Temporary Seeding	LB
1620	Fertilizer - Temporary Seeding	TN
1631	Matting for Erosion Control	SY
SP	Coir Fiber Mat	SY
SP	Coir Fiber Baffles	LF
SP	Permanent Soil Reinforcement Mat	SY
1660	Seeding and Mulching	ACR
1661	Seed - Repair Seeding	LB
1661	Fertilizer - Repair Seeding	TON
1662	Seed - Supplemental Seeding	LB
1665	Fertilizer Topdressing	TON
SP	Safety/Highly Visible Fencing	LF
SP	Response for Erosion Control	EA

Construction Methods

Provide an approved subcontractor who performs an erosion control action as described in Form 1675. Each erosion control action may include one or more of the above work items.

Measurement and Payment

Response for Erosion Control will be measured and paid for by counting the actual number of times the subcontractor moves onto the project, including borrow and waste sites, and satisfactorily completes an erosion control action described in Form 1675. The

provisions of Article 104-5 of the *Standard Specifications* will not apply to this item of work.

Payment will be made under:

Pay Item	**Pay Unit**
Response for Erosion Control	Each

ENVIRONMENTALLY SENSITIVE AREAS:

Description

This project is located in an *Environmentally Sensitive Area*. This designation requires special procedures to be used for clearing and grubbing, temporary stream crossings, and grading operations within the Environmentally Sensitive Areas identified on the plans and as designated by the Engineer. This also requires special procedures to be used for seeding and mulching and staged seeding within the project.

The Environmentally Sensitive Area shall be defined as a 50-foot buffer zone on both sides of the stream or depression measured from top of streambank or center of depression.

Construction Methods

(A) Clearing and Grubbing

In areas identified as Environmentally Sensitive Areas, the Contractor may perform clearing operations, but not grubbing operations until immediately prior to beginning grading operations as described in Article 200-1 of the *Standard Specifications*. Only clearing operations (not grubbing) shall be allowed in this buffer zone until immediately prior to beginning grading operations. Erosion control devices shall be installed immediately following the clearing operation.

(B) Grading

Once grading operations begin in identified Environmentally Sensitive Areas, work shall progress in a continuous manner until complete. All construction within these areas shall progress in a continuous manner such that each phase is complete and areas are permanently stabilized prior to beginning of next phase. Failure on the part of the Contractor to complete any phase of construction in a continuous manner in Environmentally Sensitive Areas will be just cause for the Engineer to direct the suspension of work in accordance with Article 108-7 of the *Standard Specifications*.

(C) Temporary Stream Crossings

Any crossing of streams within the limits of this project shall be accomplished in accordance with the requirements of Subarticle 107-13(B) of the *Standard Specifications*.

(D) Seeding and Mulching

Seeding and mulching shall be performed in accordance with Section 1660 of the *Standard Specifications* and vegetative cover sufficient to restrain erosion shall be installed immediately following grade establishment.

Seeding and mulching shall be performed on the areas disturbed by construction immediately following final grade establishment. No appreciable time shall lapse into the contract time without stabilization of slopes, ditches and other areas within the Environmentally Sensitive Areas.

(E) Stage Seeding

The work covered by this section shall consist of the establishment of a vegetative cover on cut and fill slopes as grading progresses. Seeding and mulching shall be done in stages on cut and fill slopes that are greater than 20 feet in height measured along the slope, or greater than 2 acres in area. Each stage shall not exceed the limits stated above.

Additional payments will not be made for the requirements of this section, as the cost for this work shall be included in the contract unit prices for the work involved.

MINIMIZE REMOVAL OF VEGETATION:

The Contractor shall minimize removal of vegetation at stream banks and disturbed areas within the project limits as directed.

STOCKPILE AREAS:

The Contractor shall install and maintain erosion control devices sufficient to contain sediment around any erodible material stockpile areas as directed.

ACCESS AND HAUL ROADS:

At the end of each working day, the Contractor shall install or re-establish temporary diversions or earth berms across access/haul roads to direct runoff into sediment devices. Silt fence sections that are temporarily removed shall be reinstalled across access/haul roads at the end of each working day.

WASTE AND BORROW SOURCES:

Payment for temporary erosion control measures, except those made necessary by the Contractor's own negligence or for his own convenience, will be paid for at the appropriate contract unit price for the devices or measures utilized in borrow sources and waste areas.

No additional payment will be made for erosion control devices or permanent seeding and mulching in any commercial borrow or waste pit. All erosion and sediment control practices that may be required on a commercial borrow or waste site will be done at the Contractor's expense.

SAFETY FENCE AND JURISDICTIONAL FLAGGING:

Description

Safety Fence shall consist of furnishing materials, installing and maintaining polyethylene or polypropylene fence along the outside riparian buffer, wetland, or water boundary, or other boundaries located within the construction corridor to mark the areas that have been approved to infringe within the buffer, wetland, endangered vegetation, culturally sensitive areas or water. The fence shall be installed prior to any land disturbing activities.

Interior boundaries for jurisdictional areas noted above shall be delineated by stakes and highly visible flagging.

Jurisdictional boundaries at staging areas, waste sites, or borrow pits, whether considered outside or interior boundaries shall be delineated by stakes and highly visible flagging.

Materials

(A) Safety Fencing

Polyethylene or polypropylene fence shall be a highly visible preconstructed safety fence approved by the Engineer. The fence material shall have an ultraviolet coating.

Either wood posts or steel posts may be used. Wood posts shall be hardwood with a wedge or pencil tip at one end, and shall be at least 5 ft. in length with a minimum nominal 2" x 2" cross section. Steel posts shall be at least 5 ft. in length, and have a minimum weight of 0.85 lb/ft of length.

(B) Boundary Flagging

Wooden stakes shall be 4 feet in length with a minimum nominal 3/4" x 1-3/4" cross section. The flagging shall be at least 1" in width. The flagging material shall be vinyl and shall be orange in color and highly visible.

Construction Methods

No additional clearing and grubbing is anticipated for the installation of this fence. The fence shall be erected to conform to the general contour of the ground.

(A) Safety Fencing

Posts shall be set at a maximum spacing of 10 ft., maintained in a vertical position and hand set or set with a post driver. If hand set, all backfill material shall be thoroughly tamped. Wood posts may be sharpened to a dull point if power driven. Posts damaged by power driving shall be removed and replaced prior to final acceptance. The tops of all wood posts shall be cut at a 30-

degree angle. The wood posts may, at the option of the Contractor, be cut at this angle either before or after the posts are erected.

The fence geotextile shall be attached to the wood posts with one 2" galvanized wire staple across each cable or to the steel posts with wire or other acceptable means.

Place construction stakes to establish the location of the safety fence in accordance with Article 105-9 or Article 801-1 of the *Standard Specifications.* No direct pay will be made for the staking of the safety fence. All stakeouts for safety fence shall be considered incidental to the work being paid for as "Construction Surveying", except that where there is no pay item for construction surveying, all safety fence stakeout will be performed by state forces.

The Contractor shall be required to maintain the safety fence in a satisfactory condition for the duration of the project as determined by the Engineer.

(B) Boundary Flagging

Boundary flagging delineation of interior boundaries shall consist of wooden stakes on 25 feet maximum intervals with highly visible orange flagging attached. Stakes shall be installed a minimum of 6" into the ground. Interior boundaries may be staked on a tangent that runs parallel to buffer but must not encroach on the buffer at any location. Interior boundaries of hand clearing shall be identified with a different colored flagging to distinguish it from mechanized clearing.

Boundary flagging delineation of interior boundaries will be placed in accordance with Article 105-9 or Article 801-1 of the *Standard Specifications*. No direct pay will be made for delineation of the interior boundaries. This delineation will be considered incidental to the work being paid for as *Construction Surveying*, except that where there is no pay item or construction surveying the cost of boundary flagging delineation shall be included in the unit prices bid for the various items in the contract. Installation for delineation of all jurisdictional boundaries at staging areas, waste sites, or borrow pits shall consist of wooden stakes on 25 feet maximum intervals with highly visible orange flagging attached. Stakes shall be installed a minimum of 6" into the ground. Additional flagging may be placed on overhanging vegetation to enhance visibility but does not substitute for installation of stakes.

Installation of boundary flagging for delineation of all jurisdictional boundaries at staging areas, waste sites, or borrow pits shall be performed in accordance with Subarticle 230-4(B)(3)(d) or Subarticle 802-2(F) of the *Standard Specifications*. No direct pay will be made for this delineation, as the cost of same shall be included in the unit prices bid for the various items in the contract.

The Contractor shall be required to maintain alternative stakes and highly visible flagging in a satisfactory condition for the duration of the project as determined by the Engineer.

Measurement and Payment

Safety Fence will be measured and paid as the actual number of linear feet of polyethylene or polypropylene fence installed in place and accepted. Such payment will be full compensation including but not limited to furnishing and installing fence geotextile with necessary posts and post bracing, staples, tie wires, tools, equipment and incidentals necessary to complete this work.

Payment will be made under:

Pay Item	**Pay Unit**
Safety Fence	Linear Foot

TEMPORARY ROCK SILT CHECK TYPE A WITH EXCELSIOR MATTING AND POLYACRYLAMIDE (PAM):

Description

Temporary Rock Silt Checks Type A with Excelsior Matting and Polyacrylamide (PAM) are devices utilized in temporary and permanent ditches to reduce runoff velocity and incorporate PAM into the construction runoff to increase settling of sediment particles and reduce turbidity of runoff. Temporary Rock Silt Checks Type A with Excelsior Matting and PAM are to be placed at locations shown on the plans or as directed. Installation shall follow the detail provided in the plans and as directed. Work includes furnishing materials, installation of Temporary Rock Silt Checks Type A, matting installation, PAM application, and removing Temporary Rock Silt Checks Type A with Excelsior Matting and PAM.

Materials

Structural stone shall be class B stone that meets the requirements of Section 1042 of the Standard Specifications for Stone for Erosion Control, Class B.

Sediment control stone shall be #5 or #57 stone, which meets the requirements of Section 1005 of the Standard Specifications for these stone sizes.

Matting shall meet the requirements of Excelsior Matting in section 1060-8(B) of the *Standard Specifications*, or shall meet specifications provided elsewhere in this contract.

Polyacrylamide (PAM) shall be applied in powder form and shall be anionic or neutrally charged. Soil samples shall be obtained in areas where the Temporary Rock Silt Checks Type A with Excelsior Matting and PAM will be placed, and from offsite material used to construct the roadway, and analyzed for the appropriate PAM flocculant to be utilized with each Temporary Rock Silt Check Type A. The PAM product used shall be listed on the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Quality (DWQ) web site as an approved PAM product for use in North Carolina.

Construction Methods

Temporary Rock Silt Checks Type A shall be installed in accordance with Section 1633-3(A) of the Standard Specifications, Roadway Standard Drawing No. 1633.01 and the detail provided in the plans.

Installation of matting shall be in accordance with the detail provided in the plans, and anchored by placing Class B stone on top of the matting at the upper and lower ends.

Apply PAM at a rate of 3.5 ounces over the center portion of the Temporary Rock Silt Checks Type A and matting where the water is going to flow over. PAM applications

shall be done during construction activities and after every rainfall event that is equal to or exceeds 0.50 in.

The Contractor shall maintain the Temporary Rock Silt Checks Type A with Excelsior Matting and PAM until the project is accepted or until the Temporary Rock Silt Checks Type A with Excelsior Matting and PAM are removed, and shall remove and dispose of silt accumulations at the Temporary Rock Silt Checks Type A with Excelsior Matting and PAM when so directed in accordance with the requirements of Section 1630 of the *Standard Specifications*.

Measurement and Payment

Temporary Rock Silt Checks Type A will be measured and paid for in accordance with section 1633-5 of the *Standard Specifications*, or in accordance with specifications provided elsewhere in this contract.

Matting will be measured and paid for in accordance with section 1631-4 of the *Standard Specifications*, or in accordance with specifications provided elsewhere in this contract.

Polyacrylamide(PAM) will be measured and paid for by the actual weight in pounds of PAM applied to the Temporary Rock Silt Checks Type A. Such price and payment will be full compensation for all work covered by this section, including, but not limited to, furnishing all materials, labor, equipment and incidentals necessary to apply the *Polyacrylamide(PAM)*.

Payment will be made under:

Pay Item	**Pay Unit**
Polyacrylamide(PAM)	Pound

Kimley»Horn

PROJECT: 17BP.7.R.37

STRUCTURE NO.: 400238

COUNTY: GUILFORD

SUBMITTAL DATE: 12/12/2014

PROJECT SPECIAL PROVISIONS

STRUCTURES

PROJECT SPECIAL PROVISION

STRUCTURES

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STEEL REINFORCED ELASTOMERIC BEARINGS **(11-27-12)**

The 2012 Standard Specifications shall be revised as follows:
In **Section 1079-1 – Preformed Bearing Pads** add the following after the second paragraph:

Internal holding pins are required for all shim plates when the contract plans indicate the structure contains the necessary corrosion protection for a corrosive site.

Repair laminated (reinforced) bearing pads utilizing external holding pins via vulcanization. Submit product data for repair material and a detailed application procedure to the Materials and Tests Unit for approval before use and annually thereafter.

FALSEWORK AND FORMWORK (4-5-12)

1.0 DESCRIPTION

Use this Special Provision as a guide to develop temporary works submittals required by the Standard Specifications or other provisions; no additional submittals are required herein. Such temporary works include, but are not limited to, falsework and formwork.

Falsework is any temporary construction used to support the permanent structure until it becomes self-supporting. Formwork is the temporary structure or mold used to retain plastic or fluid concrete in its designated shape until it hardens. Access scaffolding is a temporary structure that functions as a work platform that supports construction personnel, materials, and tools, but is not intended to support the structure. Scaffolding systems that are used to temporarily support permanent structures (as opposed to functioning as work platforms) are considered to be falsework under the definitions given. Shoring is a component of falsework such as horizontal, vertical, or inclined support members. Where the term "temporary works" is used, it includes all of the temporary facilities used in bridge construction that do not become part of the permanent structure.

Design and construct safe and adequate temporary works that will support all loads imposed and provide the necessary rigidity to achieve the lines and grades shown on the plans in the final structure.

2.0 MATERIALS

Select materials suitable for temporary works; however, select materials that also ensure the safety and quality required by the design assumptions. The Engineer has authority to reject material on the basis of its condition, inappropriate use, safety, or nonconformance with the plans. Clearly identify allowable loads or stresses for all materials or manufactured devices on the plans. Revise the plan and notify the Engineer if any change to materials or material strengths is required.

3.0 DESIGN REQUIREMENTS

A. Working Drawings

Provide working drawings for items as specified in the contract, or as required by the Engineer, with design calculations and supporting data in sufficient detail to permit a structural and safety review of the proposed design of the temporary work.

On the drawings, show all information necessary to allow the design of any component to be checked independently as determined by the Engineer.

When concrete placement is involved, include data such as the drawings of proposed sequence, rate of placement, direction of placement, and location of all construction joints. Submit the number of copies as called for by the contract.

When required, have the drawings and calculations prepared under the guidance of, and sealed by, a North Carolina Registered Professional Engineer who is knowledgeable in temporary works design.

If requested by the Engineer, submit with the working drawings manufacturer's catalog data listing the weight of all construction equipment that will be supported on the temporary work. Show anticipated total settlements and/or deflections of falsework and forms on the working drawings. Include falsework footing settlements, joint take-up, and deflection of beams or girders.

As an option for the Contractor, overhang falsework hangers may be uniformly spaced, at a maximum of 36 inches, provided the following conditions are met:

Member Type (PCG)	Member Depth, (inches)	Max. Overhang Width, (inches)	Max. Slab Edge Thickness, (inches)	Max. Screed Wheel Weight, (lbs.)	Bracket Min. Vertical Leg Extension, (inches)
II	36	39	14	2000	26
III	45	42	14	2000	35
IV	54	45	14	2000	44
MBT	63	51	12	2000	50
MBT	72	55	12	1700	48

Overhang width is measured from the centerline of the girder to the edge of the deck slab.

For Type II, III & IV prestressed concrete girders (PCG), 45-degree cast-in-place half hangers and rods must have a minimum safe working load of 6,000 lbs.

For MBT prestressed concrete girders, 45-degree angle holes for falsework hanger rods shall be cast through the girder top flange and located, measuring along the top of the member, 1'-2 ½" from the edge of the top flange. Hanger hardware and rods must have a minimum safe working load of 6,000 lbs.

The overhang bracket provided for the diagonal leg shall have a minimum safe working load of 3,750 lbs. The vertical leg of the bracket shall extend to the point that the heel bears on the girder bottom flange, no closer than 4 inches from the bottom of the member. However, for 72-inch members, the heel of the bracket shall bear on the web, near the bottom flange transition.

Provide adequate overhang falsework and determine the appropriate adjustments for deck geometry, equipment, casting procedures and casting conditions.

If the optional overhang falsework spacing is used, indicate this on the falsework submittal and advise the girder producer of the proposed details. Failure to notify the Engineer of hanger type and hanger spacing on prestressed concrete girder casting drawings may delay the approval of those drawings.

Falsework hangers that support concentrated loads and are installed at the edge of thin top flange concrete girders (such as bulb tee girders) shall be spaced so as not to exceed 75% of the manufacturer's stated safe working load. Use of dual leg hangers (such as Meadow Burke HF-42 and HF-43) are not allowed on concrete girders with thin top flanges. Design the falsework and forms supporting deck slabs and overhangs on girder bridges so that there will be no differential settlement between the girders and the deck forms during placement of deck concrete.

When staged construction of the bridge deck is required, detail falsework and forms for screed and fluid concrete loads to be independent of any previous deck pour components when the mid-span girder deflection due to deck weight is greater than ¾".

Note on the working drawings any anchorages, connectors, inserts, steel sleeves or other such devices used as part of the falsework or formwork that remains in the permanent structure. If the plan notes indicate that the structure contains the necessary corrosion protection required for a Corrosive Site, epoxy coat, galvanize or metalize these devices. Electroplating will not be allowed. Any coating required by the Engineer will be considered incidental to the various pay items requiring temporary works.

Design falsework and formwork requiring submittals in accordance with the 1995 AASHTO *Guide Design Specifications for Bridge Temporary Works* except as noted herein.

1. Wind Loads

   Table 2.2 of Article 2.2.5.1 is modified to include wind velocities up to 110 mph. In addition, Table 2.2A is included to provide the maximum wind speeds by county in North Carolina.

Table 2.2 - Wind Pressure Values

Height Zone feet above ground	Pressure, lb/ft^2 for Indicated Wind Velocity, mph				
	70	80	90	100	110
0 to 30	15	20	25	30	35
30 to 50	20	25	30	35	40
50 to 100	25	30	35	40	45
over 100	30	35	40	45	50

2. Time of Removal

   The following requirements replace those of Article 3.4.8.2.

   Do not remove forms until the concrete has attained strengths required in Article 420-16 of the Standard Specifications and these Special Provisions.

   Do not remove forms until the concrete has sufficient strength to prevent damage to the surface.

Table 2.2A - Steady State Maximum Wind Speeds by Counties in North Carolina

COUNTY	25 YR (mph)	COUNTY	25 YR (mph)	COUNTY	25 YR (mph)
Alamance	70	Franklin	70	Pamlico	100
Alexander	70	Gaston	70	Pasquotank	100
Alleghany	70	Gates	90	Pender	100
Anson	70	Graham	80	Perquimans	100
Ashe	70	Granville	70	Person	70
Avery	70	Greene	80	Pitt	90
Beaufort	100	Guilford	70	Polk	80
Bertie	90	Halifax	80	Randolph	70
Bladen	90	Harnett	70	Richmond	70
Brunswick	100	Haywood	80	Robeson	80
Buncombe	80	Henderson	80	Rockingham	70
Burke	70	Hertford	90	Rowan	70
Cabarrus	70	Hoke	70	Rutherford	70
Caldwell	70	Hyde	110	Sampson	90
Camden	100	Iredell	70	Scotland	70
Carteret	110	Jackson	80	Stanley	70
Caswell	70	Johnston	80	Stokes	70
Catawba	70	Jones	100	Surry	70
Cherokee	80	Lee	70	Swain	80
Chatham	70	Lenoir	90	Transylvania	80
Chowan	90	Lincoln	70	Tyrell	100
Clay	80	Macon	80	Union	70
Cleveland	70	Madison	80	Vance	70
Columbus	90	Martin	90	Wake	70
Craven	100	McDowell	70	Warren	70
Cumberland	80	Mecklenburg	70	Washington	100
Currituck	100	Mitchell	70	Watauga	70
Dare	110	Montgomery	70	Wayne	80
Davidson	70	Moore	70	Wilkes	70
Davie	70	Nash	80	Wilson	80
Duplin	90	New Hanover	100	Yadkin	70
Durham	70	Northampton	80	Yancey	70
Edgecombe	80	Onslow	100		
Forsyth	70	Orange	70		

B. Review and Approval

The Engineer is responsible for the review and approval of temporary works' drawings.

Submit the working drawings sufficiently in advance of proposed use to allow for their review, revision (if needed), and approval without delay to the work.

The time period for review of the working drawings does not begin until complete drawings and design calculations, when required, are received by the Engineer.

Do not start construction of any temporary work for which working drawings are required until the drawings have been approved. Such approval does not relieve the Contractor of the responsibility for the accuracy and adequacy of the working drawings.

4.0 CONSTRUCTION REQUIREMENTS

All requirements of Section 420 of the Standard Specifications apply.

Construct temporary works in conformance with the approved working drawings. Ensure that the quality of materials and workmanship employed is consistent with that assumed in the design of the temporary works. Do not weld falsework members to any portion of the permanent structure unless approved. Show any welding to the permanent structure on the approved construction drawings.

Provide tell-tales attached to the forms and extending to the ground, or other means, for accurate measurement of falsework settlement. Make sure that the anticipated compressive settlement and/or deflection of falsework does not exceed 1 inch. For cast-in-place concrete structures, make sure that the calculated deflection of falsework flexural members does not exceed 1/240 of their span regardless of whether or not the deflection is compensated by camber strips.

A. Maintenance and Inspection

Inspect and maintain the temporary work in an acceptable condition throughout the period of its use. Certify that the manufactured devices have been maintained in a condition to allow them to safely carry their rated loads. Clearly mark each piece so that its capacity can be readily determined at the job site.

Perform an in-depth inspection of an applicable portion(s) of the temporary works, in the presence of the Engineer, not more than 24 hours prior to the beginning of each concrete placement. Inspect other temporary works at least once a month to ensure that they are functioning properly. Have a North Carolina Registered Professional Engineer inspect the cofferdams, shoring, sheathing, support of excavation structures, and support systems for load tests prior to loading.

B. Foundations

Determine the safe bearing capacity of the foundation material on which the supports for temporary works rest. If required by the Engineer, conduct load tests to verify proposed bearing capacity values that are marginal or in other high-risk situations.

The use of the foundation support values shown on the contract plans of the permanent structure is permitted if the foundations are on the same level and on the same soil as those of the permanent structure.

Allow for adequate site drainage or soil protection to prevent soil saturation and washout of the soil supporting the temporary works supports.

If piles are used, the estimation of capacities and later confirmation during construction using standard procedures based on the driving characteristics of the pile is permitted. If preferred, use load tests to confirm the estimated capacities; or, if required by the Engineer conduct load tests to verify bearing capacity values that are marginal or in other high risk situations.

The Engineer reviews and approves the proposed pile and soil bearing capacities.

5.0 REMOVAL

Unless otherwise permitted, remove and keep all temporary works upon completion of the work. Do not disturb or otherwise damage the finished work.

Remove temporary works in conformance with the contract documents. Remove them in such a manner as to permit the structure to uniformly and gradually take the stresses due to its own weight.

6.0 METHOD OF MEASUREMENT

Unless otherwise specified, temporary works will not be directly measured.

7.0 BASIS OF PAYMENT

Payment at the contract unit prices for the various pay items requiring temporary works will be full compensation for the above falsework and formwork.

SUBMITTAL OF WORKING DRAWINGS (8-9-13)

1.0 GENERAL

Submit working drawings in accordance with Article 105-2 of the *Standard Specifications* and this provision. For this provision, "submittals" refers to only those listed in this provision. The list of submittals contained herein does not represent a list of required submittals for the project. Submittals are only necessary for those items as required by the contract. Make submittals that are not specifically noted in this provision directly to the Resident Engineer. Either the Structure Design Unit or the Geotechnical Engineering Unit or both units will jointly review submittals.

If a submittal contains variations from plan details or specifications or significantly affects project cost, field construction or operations, discuss the submittal with and submit all copies to the Resident Engineer. State the reason for the proposed variation in the submittal. To minimize review time, make sure all submittals are complete when initially submitted. Provide a contact name and information with each submittal. Direct any questions regarding submittal requirements to the Resident Engineer, Structure Design Unit contacts or the Geotechnical Engineering Unit contacts noted below.

In order to facilitate in-plant inspection by NCDOT and approval of working drawings, provide the name, address and telephone number of the facility where fabrication will actually be done if different than shown on the title block of the submitted working drawings. This includes, but is not limited to, precast concrete items, prestressed concrete items and fabricated steel or aluminum items.

2.0 ADDRESSES AND CONTACTS

For submittals to the Structure Design Unit, use the following addresses:

Via US mail:

Mr. G. R. Perfetti, P. E.
State Structures Engineer
North Carolina Department
of Transportation
Structures Management Unit
1581 Mail Service Center
Raleigh, NC 27699-1581

Attention: Mr. P. D. Lambert, P. E.

Via other delivery service:

Mr. G. R. Perfetti, P. E.
State Structures Engineer
North Carolina Department
of Transportation
Structures Management Unit
1000 Birch Ridge Drive
Raleigh, NC 27610

Attention: Mr. P. D. Lambert, P. E.

Submittals may also be made via email.

Send submittals to:

plambert@ncdot.gov (Paul Lambert)

Send an additional e-copy of the submittal to the following address:

jgaither@ncdot.gov (James Gaither)

jlbolden@ncdot.gov (James Bolden)

For submittals to the Geotechnical Engineering Unit, use the following addresses:

For projects in Divisions 1-7, use the following Eastern Regional Office address:

Via US mail:

Mr. K. J. Kim, Ph. D., P. E.
Eastern Regional Geotechnical Manager
North Carolina Department of Transportation
Geotechnical Engineering Unit
Eastern Regional Office
1570 Mail Service Center
Raleigh, NC 27699-1570

Via other delivery service:

Mr. K. J. Kim, Ph. D., P. E.
Eastern Regional Geotechnical Manager
North Carolina Department of Transportation
Geotechnical Engineering Unit
Eastern Regional Office
3301 Jones Sausage Road, Suite 100
Garner, NC 27529

For projects in Divisions 8-14, use the following Western Regional Office address:

Via US mail:

Mr. Eric Williams, P. E.
Western Regional Geotechnical Manager
North Carolina Department of Transportation
Geotechnical Engineering Unit
Western Regional Office
5253 Z Max Boulevard
Harrisburg, NC 28075

Via other delivery service:

Mr. Eric Williams, P. E.
Western Region Geotechnical Manager
North Carolina Department of Transportation
Geotechnical Engineering Unit
Western Regional Office
5253 Z Max Boulevard
Harrisburg, NC 28075

The status of the review of structure-related submittals sent to the Structure Design Unit can be viewed from the Unit's web site, via the "Contractor Submittal" link.

Direct any questions concerning submittal review status, review comments or drawing markups to the following contacts:

Primary Structures Contact: Paul Lambert (919) 707 – 6407
(919) 250 – 4082 facsimile
plambert@ncdot.gov

Secondary Structures Contacts: James Gaither (919) 707 – 6409
James Bolden (919) 707 – 6408

Eastern Regional Geotechnical Contact (Divisions 1-7):
K. J. Kim (919) 662 – 4710
(919) 662 – 3095 facsimile
kkim@ncdot.gov

Western Regional Geotechnical Contact (Divisions 8-14):

Eric Williams (704) 455 – 8902
(704) 455 – 8912 facsimile
ewilliams@ncdot.gov

3.0 SUBMITTAL COPIES

Furnish one complete copy of each submittal, including all attachments, to the Resident Engineer. At the same time, submit the number of hard copies shown below of the same complete submittal directly to the Structure Design Unit and/or the Geotechnical Engineering Unit.

The first table below covers "Structure Submittals". The Resident Engineer will receive review comments and drawing markups for these submittals from the Structure Design Unit. The second table in this section covers "Geotechnical Submittals". The Resident Engineer will receive review comments and drawing markups for these submittals from the Geotechnical Engineering Unit.

Unless otherwise required, submit one set of supporting calculations to either the Structure Design Unit or the Geotechnical Engineering Unit unless both units require submittal copies in which case submit a set of supporting calculations to each unit. Provide additional copies of any submittal as directed.

STRUCTURE SUBMITTALS

Submittal	Copies Required by Structure Design Unit	Copies Required by Geotechnical Engineering Unit	Contract Reference Requiring Submittal [1]
Arch Culvert Falsework	5	0	Plan Note, SN Sheet & "Falsework and Formwork"
Box Culvert Falsework [7]	5	0	Plan Note, SN Sheet & "Falsework and Formwork"
Cofferdams	6	2	Article 410-4
Foam Joint Seals [6]	9	0	"Foam Joint Seals"
Expansion Joint Seals (hold down plate type with base angle)	9	0	"Expansion Joint Seals"
Expansion Joint Seals (modular)	2, then 9	0	"Modular Expansion Joint Seals"

Expansion Joint Seals (strip seals)	9	0	"Strip Seals"
Falsework & Forms [2] (substructure)	8	0	Article 420-3 & "Falsework and Formwork"
Falsework & Forms (superstructure)	8	0	Article 420-3 & "Falsework and Formwork"
Girder Erection over Railroad	5	0	Railroad Provisions
Maintenance and Protection of Traffic Beneath Proposed Structure	8	0	"Maintenance and Protection of Traffic Beneath Proposed Structure at Station ___"
Metal Bridge Railing	8	0	Plan Note
Metal Stay-in-Place Forms	8	0	Article 420-3
Metalwork for Elastomeric Bearings [4,5]	7	0	Article 1072-8
Miscellaneous Metalwork [4,5]	7	0	Article 1072-8
Optional Disc Bearings [4]	8	0	"Optional Disc Bearings"
Overhead and Digital Message Signs (DMS) (metalwork and foundations)	13	0	Applicable Provisions
Placement of Equipment on Structures (cranes, etc.)	7	0	Article 420-20
Pot Bearings [4]	8	0	"Pot Bearings"
Precast Concrete Box Culverts	2, then 1 reproducible	0	"Optional Precast Reinforced Concrete Box Culvert at Station ___"
Prestressed Concrete Cored Slab (detensioning sequences) [3]	6	0	Article 1078-11
Prestressed Concrete Deck Panels	6 and 1 reproducible	0	Article 420-3
Prestressed Concrete Girder (strand elongation and detensioning sequences)	6	0	Articles 1078-8 and 1078-11
Removal of Existing Structure over Railroad	5	0	Railroad Provisions

Revised Bridge Deck Plans (adaptation to prestressed deck panels)	2, then 1 reproducible	0	Article 420-3
Revised Bridge Deck Plans (adaptation to modular expansion joint seals)	2, then 1 reproducible	0	"Modular Expansion Joint Seals"
Sound Barrier Wall (precast items)	10	0	Article 1077-2 & "Sound Barrier Wall"
Sound Barrier Wall Steel Fabrication Plans [5]	7	0	Article 1072-8 & "Sound Barrier Wall"
Structural Steel [4]	2, then 7	0	Article 1072-8
Temporary Detour Structures	10	2	Article 400-3 & "Construction, Maintenance and Removal of Temporary Structure at Station ____"
TFE Expansion Bearings [4]	8	0	Article 1072-8

FOOTNOTES

1. References are provided to help locate the part of the contract where the submittals are required. References in quotes refer to the provision by that name. Articles refer to the *Standard Specifications*.
2. Submittals for these items are necessary only when required by a note on plans.
3. Submittals for these items may not be required. A list of pre-approved sequences is available from the producer or the Materials & Tests Unit.
4. The fabricator may submit these items directly to the Structure Design Unit.
5. The two sets of preliminary submittals required by Article 1072-8 of the *Standard Specifications* are not required for these items.
6. Submittals for Fabrication Drawings are not required. Submittals for Catalogue Cuts of Proposed Material are required. See Section 5.A of the referenced provision.
7. Submittals are necessary only when the top slab thickness is 18" or greater.

GEOTECHNICAL SUBMITTALS

Submittal	Copies Required by Geotechnical Engineering Unit	Copies Required by Structure Design Unit	Contract Reference Requiring Submittal [1]
Drilled Pier Construction Plans [2]	1	0	Subarticle 411-3(A)
Crosshole Sonic Logging (CSL) Reports [2]	1	0	Subarticle 411-5(A)(2)
Pile Driving Equipment Data Forms [2,3]	1	0	Subarticle 450-3(D)(2)
Pile Driving Analyzer (PDA) Reports [2]	1	0	Subarticle 450-3(F)(3)
Retaining Walls [4]	8 drawings, 2 calculations	2 drawings	Applicable Provisions
Temporary Shoring [4]	5 drawings, 2 calculations	2 drawings	"Temporary Shoring" & "Temporary Soil Nail Walls"

FOOTNOTES

1. References are provided to help locate the part of the contract where the submittals are required. References in quotes refer to the provision by that name. Subarticles refer to the *Standard Specifications*.

2. Submit one hard copy of submittal to the Resident or Bridge Maintenance Engineer. Submit a second copy of submittal electronically (PDF via email) or by facsimile, US mail or other delivery service to the appropriate Geotechnical Engineering Unit regional office. Electronic submission is preferred.

3. The Pile Driving Equipment Data Form is available from:
   https://connect.ncdot.gov/resources/Geological/Pages/Geotech_Forms_Details.aspx
   See second page of form for submittal instructions.

4. Electronic copy of submittal is required. See referenced provision.

CRANE SAFETY (8-15-05)

Comply with the manufacturer specifications and limitations applicable to the operation of any and all cranes and derricks. Prime contractors, sub-contractors, and fully operated rental companies shall comply with the current Occupational Safety and Health Administration regulations (OSHA).

Submit all items listed below to the Engineer prior to beginning crane operations involving critical lifts. A critical lift is defined as any lift that exceeds 75 percent of the manufacturer's crane chart capacity for the radius at which the load will be lifted or requires the use of more than one crane. Changes in personnel or equipment must be reported to the Engineer and all applicable items listed below must be updated and submitted prior to continuing with crane operations.

CRANE SAFETY SUBMITTAL LIST

A. **Competent Person:** Provide the name and qualifications of the "Competent Person" responsible for crane safety and lifting operations. The named competent person will have the responsibility and authority to stop any work activity due to safety concerns.

B. **Riggers:** Provide the qualifications and experience of the persons responsible for rigging operations. Qualifications and experience should include, but not be limited to, weight calculations, center of gravity determinations, selection and inspection of sling and rigging equipment, and safe rigging practices.

C. **Crane Inspections:** Inspection records for all cranes shall be current and readily accessible for review upon request.

D. **Certifications:** **By July 1, 2006**, crane operators performing critical lifts shall be certified by NC CCO (National Commission for the Certification of Crane Operators), or satisfactorily complete the Carolinas AGC's Professional Crane Operator's Proficiency Program. Other approved nationally accredited programs will be considered upon request. All crane operators shall also have a current CDL medical card. Submit a list of anticipated critical lifts and corresponding crane operator(s). Include current certification for the type of crane operated (small hydraulic, large hydraulic, small lattice, large lattice) and medical evaluations for each operator.

GROUT FOR STRUCTURES (9-30-11)

1.0 DESCRIPTION

This special provision addresses grout for use in pile blockouts, grout pockets, shear keys, dowel holes and recesses for structures. This provision does not apply to grout placed in post-tensioning ducts for bridge beams, girders, or decks. Mix and place grout in accordance with the manufacturer's recommendations, the applicable sections of the Standard Specifications and this provision.

2.0 MATERIAL REQUIREMENTS

Use a Department approved pre-packaged, non-shrink, non-metallic grout. Contact the Materials and Tests Unit for a list of approved pre-packaged grouts and consult the manufacturer to determine if the pre-packaged grout selected is suitable for the required application.

When using an approved pre-packaged grout, a grout mix design submittal is not required.

The grout shall be free of soluble chlorides and contain less than one percent soluble sulfate. Supply water in compliance with Article 1024-4 of the Standard Specifications.

Aggregate may be added to the mix only where recommended or permitted by the manufacturer and Engineer. The quantity and gradation of the aggregate shall be in accordance with the manufacturer's recommendations.

Admixtures, if approved by the Department, shall be used in accordance with the manufacturer's recommendations. The manufacture date shall be clearly stamped on each container. Admixtures with an expired shelf life shall not be used.

The Engineer reserves the right to reject material based on unsatisfactory performance.

Initial setting time shall not be less than 10 minutes when tested in accordance with ASTM C266.

Test the expansion and shrinkage of the grout in accordance with ASTM C1090. The grout shall expand no more than 0.2% and shall exhibit no shrinkage. Furnish a Type 4 material certification showing results of tests conducted to determine the properties listed in the Standard Specifications and to assure the material is non-shrink.

Unless required elsewhere in the contract the compressive strength at 3 days shall be at least 5000 psi. Compressive strength in the laboratory shall be determined in accordance with ASTM C109 except the test mix shall contain only water and the dry manufactured material. Compressive strength in the field will be determined by molding and testing 4" x 8" cylinders in accordance with AASHTO T22. Construction loading and traffic loading shall not be allowed until the 3 day compressive strength is achieved.

When tested in accordance with ASTM C666, Procedure A, the durability factor of the grout shall not be less than 80.

3.0 SAMPLING AND PLACEMENT

Place and maintain components in final position until grout placement is complete and accepted. Concrete surfaces to receive grout shall be free of defective concrete, laitance, oil, grease and other foreign matter. Saturate concrete surfaces with clean water and remove excess water prior to placing grout.

Do not place grout if the grout temperature is less than 50°F or more than 90°F or if the air temperature measured at the location of the grouting operation in the shade away from artificial heat is below 45°F.

Provide grout at a rate that permits proper handling, placing and finishing in accordance with the manufacturer's recommendations unless directed otherwise by the Engineer. Use grout free of any lumps and undispersed cement. Agitate grout continuously before placement.

Control grout delivery so the interval between placing batches in the same component does not exceed 20 minutes.

The Engineer will determine the locations to sample grout and the number and type of samples collected for field and laboratory testing. The compressive strength of the grout will be considered the average compressive strength test results of 3 cube or 2 cylinder specimens at 28 days.

4.0 BASIS OF PAYMENT

No separate payment will be made for "Grout for Structures". The cost of the material, equipment, labor, placement, and any incidentals necessary to complete the work shall be considered incidental to the structure item requiring grout.

North Carolina Department of Environment and Natural Resources
Division of Water Quality
Pat McCrory
Governor
Charles Wakild, P. E.
Director
John E. Skvarla, III
Secretary

May 20, 2013
Guilford County
NCDWQ Project No. 20130478
(Bridge 238) SR 1005
State Project No. 17BP.7.R.37

APPROVAL of JORDAN BUFFER AUTHORIZATION with ADDITIONAL CONDITIONS

Mr. Mike Mills, P.E., Division Engineer
NCDOT, Division 7
PO Box 14996
Greensboro, NC 27415-4996

Dear Mr. Mills:

You have our approval, in accordance with the conditions listed below, for the following impacts for the purpose of replacing Bridge no. 238 on SR 1005 (Alamance Church Road) in Guilford County:

Jordan Lake Riparian Buffer Impacts

Site (impact type)	Zone 1 Impact (sq ft)	*minus* Wetlands in Zone 1 (sq ft)	= Zone 1 Buffers (not wetlands) (sq ft)	Zone 1 Buffer Mitigation Required (using 3:1 ratio)	Zone 2 Impact (sq ft)	*minus* Wetlands in Zone 2 (sq ft)	= Zone 2 Buffers (not wetlands) (sq ft)	Zone 2 Buffer Mitigation Required (using 1.5:1 ratio)
1 (Bridge)	3317		3317		1376		1376	
1 (roadway)	38		38		713		713	
1 (ditch)	0		0		91		91	
2 (temporary bridge)	2753		2753		2505		2505	
Totals	**6108**		**6108**		**4685**		**4685**	

Total Buffer Impact for Project: 10793 square feet.

The project shall be constructed in accordance with your application dated received May 6, 2013and additional information dated received May 17, 2013. This approval is valid for the Jordan Lake Riparian Buffer Rules (15A NCAC 2B .0267). In addition, you should acquire any other federal, state or local permits before you proceed with your project including (but not limited to) Sediment and Erosion Control, Non-Discharge and Water Supply Watershed regulations. This approval expires five years from the date it was issued.
This approval is valid solely for the purpose and design described in your application (unless modified below). Should your project change, you must notify the NCDWQ and submit a new application. If the property is sold, the new owner must be given a copy of this Certification and approval letter, and is thereby responsible for complying with all the conditions. If total wetland fills for this project (now or in the future) exceed one acre, or of total impacts to streams (now or in the future) exceed 150 linear feet, compensatory mitigation may be required as

Transportation and Permitting Unit
1650 Mail Service Center, Raleigh, North Carolina 27699-1617
Location: 512 N. Salisbury St. Raleigh, North Carolina 27604
Phone: 919-807-6300 \ FAX: 919-807-6492
Internet: www.ncwaterquality.org

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described in 15A NCAC 2H .0506 (h) (6) and (7). Additional buffer impacts may require compensatory mitigation as described in 15A NCAC.0268. For this approval to remain valid, you must adhere to the conditions listed below.

Condition(s) of Certification:

Project Specific Conditions

1. Strict adherence to the most recent version of NCDOT's Best Management Practices For Bridge Demolition and Removal approved by the US Army Corps of Engineers is a condition of the 401 Water Quality Certification.
2. Bridge deck drains shall not discharge directly into the stream. Stormwater shall be directed across the bridge and pre-treated through site-appropriate means (grassed swales, pre-formed scour holes, vegetated buffers, etc.) before entering the stream. Please refer to the most current version of *Stormwater Best Management Practices*.
3. No drill slurry or water that has been in contact with uncured concrete shall be allowed to enter surface waters. This water shall be captured, treated, and disposed of properly.
4. Post-construction stormwater shall be designed as approved in updated plan drawings dated received May 6, 2013and additional information dated received May 17, 2013. . If any changes are made to the post-construction stormwater design, the Division of Water Quality shall be contacted for approval of the changes.
5. All riparian buffers impacted by the placement of temporary fill or clearing activities shall be restored to the preconstruction contours and revegetated. Maintained buffers shall be permanently revegetated with non-woody species by the end of the growing season following completion of construction. For the purpose of this condition, maintained buffer areas are defined as areas within the transportation corridor that will be subject to regular NCDOT maintenance activities including mowing. The area with non-maintained buffers shall be permanently revegetated with native woody species before the next growing season following completion of construction.
6. Pursuant to 15A NCAC 2B .0267, sediment and erosion control devices shall not be placed in Zone 1 of any Jordan Buffer without prior approval by NCDWQ. At this time, NCDWQ has approved no sediment and erosion control devices in Zone 1, outside of the approved project impacts, anywhere on this project. Moreover, sediment and erosion control devices shall be allowed in Zone 2 of the buffers provided that Zone 1 is not compromised and that discharge is released as diffuse flow.

General Conditions

1. During the construction of the project, no staging of equipment of any kind is permitted in waters of the U.S., or protected riparian buffers.
2. The dimension, pattern and profile of the stream above and below the crossing shall not be modified. Disturbed floodplains and streams shall be restored to natural geomorphic conditions.
3. The Permittee shall ensure that the final design drawings adhere to the permit and to the permit drawings submitted for approval.
4. All work in or adjacent to stream waters shall be conducted in a dry work area. Approved BMP measures from the most current version of NCDOT Construction and Maintenance Activities manual such as sandbags, rock berms, cofferdams and other diversion structures shall be used to prevent excavation in flowing water.
5. Heavy equipment shall be operated from the banks rather than in the stream channel in order to minimize sedimentation and reduce the introduction of other pollutants into the stream.
6. All mechanized equipment operated near surface waters must be regularly inspected and maintained to prevent contamination of stream waters from fuels, lubricants, hydraulic fluids, or other toxic materials.
7. No rock, sand or other materials shall be dredged from the stream channel except where authorized by this certification.
8. Discharging hydroseed mixtures and washing out hydroseeders and other equipment in or adjacent to surface waters is prohibited.
9. A copy of this Water Quality Certification shall be maintained on the construction site at all times. In addition, the Water Quality Certification and all subsequent modifications, if any, shall be maintained with the Division Engineer and the on-site project manager.
10. The outside buffer, wetland or water boundary located within the construction corridor approved by this authorization shall be clearly marked by highly visible fencing prior to any land disturbing activities. Impacts to areas within the fencing are prohibited unless otherwise authorized by this certification.
11. The issuance of this certification does not exempt the Permittee from complying with any and all statutes, rules, regulations, or ordinances that may be imposed by other government agencies (i.e. local, state, and

10. The outside buffer, wetland or water boundary located within the construction corridor approved by this authorization shall be clearly marked by highly visible fencing prior to any land disturbing activities. Impacts to areas within the fencing are prohibited unless otherwise authorized by this certification.
11. The issuance of this certification does not exempt the Permittee from complying with any and all statutes, rules, regulations, or ordinances that may be imposed by other government agencies (i.e. local, state, and federal) having jurisdiction, including but not limited to applicable buffer rules, stormwater management rules, soil erosion and sedimentation control requirements, etc.
12. The Permittee shall report any violations of this certification to the Division of Water Quality within 24 hours of discovery.
13. Upon completion of the project (including any impacts at associated borrow or waste sites), the NCDOT Division Engineer shall complete and return the enclosed "Certification of Completion Form" to notify NCDWQ when all work included in the 401 Certification has been completed.
14. Native riparian vegetation must be reestablished in the riparian areas within the construction limits of the project by the end of the growing season following completion of construction.
15. There shall be no excavation from, or waste disposal into, jurisdictional wetlands or waters associated with this permit without appropriate modification. Should waste or borrow sites, or access roads to waste or borrow sites, be located in wetlands or streams, compensatory mitigation will be required since that is a direct impact from road construction activities.
16. Erosion and sediment control practices must be in full compliance with all specifications governing the proper design, installation and operation and maintenance of such Best Management Practices in order to protect surface waters standards:
    a. The erosion and sediment control measures for the project must be designed, installed, operated, and maintained in accordance with the most recent version of the *North Carolina Sediment and Erosion Control Planning and Design Manual.*
    b. The design, installation, operation, and maintenance of the sediment and erosion control measures must be such that they equal, or exceed, the requirements specified in the most recent version of the *North Carolina Sediment and Erosion Control Manual.* The devices shall be maintained on all construction sites, borrow sites, and waste pile (spoil) projects, including contractor-owned or leased borrow pits associated with the project.
    c. For borrow pit sites, the erosion and sediment control measures must be designed, installed, operated, and maintained in accordance with the most recent version of the *North Carolina Surface Mining Manual.*
    d. The reclamation measures and implementation must comply with the reclamation in accordance with the requirements of the Sedimentation Pollution Control Act.
17. Sediment and erosion control measures shall not be placed in wetlands or waters unless otherwise approved by this Certification.

If you wish to contest any statement in the attached Certification you must file a petition for an administrative hearing. You may obtain the petition form from the office of Administrative hearings. You must file the petition with the office of Administrative Hearings within sixty (60) days of receipt of this notice. A petition is considered filed when it is received in the office of Administrative Hearings during normal office hours. The Office of Administrative Hearings accepts filings Monday through Friday between the hours of 8:00am and 5:00pm, except for official state holidays. The original and one (1) copy of the petition must be filed with the Office of Administrative Hearings.

The petition may be faxed-provided the original and one copy of the document is received by the Office of Administrative Hearings within five (5) business days following the faxed transmission.
The mailing address for the Office of Administrative Hearings is:

Office of Administrative Hearings
6714 Mail Service Center
Raleigh, NC 27699-6714
Telephone: (919)-431-3000, Facsimile: (919)-431-3100

A copy of the petition must also be served on DENR as follows:

Mr. Lacy Presnell, General Counsel
Department of Environment and Natural Resources
1601 Mail Service Center

This letter completes the review of the Division of Water Quality under Section 401 of the Clean Water Act. If you have any questions, please contact Amy Euliss at (336) 771-4959 or amy.euliss@ncdenr.gov.

Sincerely,

for Charles Wakild
Director

cc: Jerry Parker, Division 7 Environmental Officer
Wetlands/401 Transportation Permitting Unit
File Copy

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Water Quality
Pat McCrory, Governor
Charles Wakild, P. E., Director
John E. Skvarla, III, Secretary

NCDWQ Project No.: _____ **County:** _____

Applicant: _____

Project Name: _____

Date of Issuance of 401 Water Quality Certification: _____

Certificate of Completion
Upon completion of all work approved within the 401 Water Quality Certification or applicable Buffer Rules, and any subsequent modifications, the applicant is required to return this certificate to the 401 Transportation Permitting Unit, North Carolina Division of Water Quality, 1650 Mail Service Center, Raleigh, NC, 27699-1650. This form may be returned to NCDWQ by the applicant, the applicant's authorized agent, **or** the project engineer. It is not necessary to send certificates from all of these.

Applicant's Certification

I, _____, hereby state that, to the best of my abilities, due care and diligence was used in the observation of the construction such that the construction was observed to be built within substantial compliance and intent of the 401 Water Quality Certification and Buffer Rules, the approved plans and specifications, and other supporting materials.

Signature: _____ Date: _____

Agent's Certification

I, _____, hereby state that, to the best of my abilities, due care and diligence was used in the observation of the construction such that the construction was observed to be built within substantial compliance and intent of the 401 Water Quality Certification and Buffer Rules, the approved plans and specifications, and other supporting materials.

Signature: _____ Date: _____

Engineer's Certification

_____ Partial _____ Final

I, _____, as a duly registered Professional Engineer in the State of North Carolina, having been authorized to observe (periodically, weekly, full time) the construction of the project for the Permittee hereby state that, to the best of my abilities, due care and diligence was used in the observation of the construction such that the construction was observed to be built within substantial compliance and intent of the 401 Water Quality Certification and Buffer Rules, the approved plans and specifications, and other supporting materials.

Signature _____ Registration No. _____

Date _____

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Internet: www.ncwaterquality.org

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EXECUTION OF BID

NON-COLLUSION AFFIDAVIT, DEBARMENT CERTIFICATION AND GIFT BAN CERTIFICATION

CORPORATION

The person executing the bid, on behalf of the Bidder, being duly sworn, solemnly swears (or affirms) that neither he, nor any official, agent or employee of the bidder has entered into any agreement, participated in any collusion, or otherwise taken any action which is in restraint of free competitive bidding in connection with any bid or contract, that the bidder has not been convicted of violating *N.C.G.S. § 133-24* within the last three years, and that the Bidder intends to do the work with its own bonafide employees or subcontractors and is not bidding for the benefit of another contractor.

In addition, execution of this bid in the proper manner also constitutes the Bidder's certification of status under penalty of perjury under the laws of the United States in accordance with the Debarment Certification attached, provided that the Debarment Certification also includes any required statements concerning exceptions that are applicable.

N.C.G.S. § 133-32 and Executive Order 24 prohibit the offer to, or acceptance by, any State Employee of any gift from anyone with a contract with the State, or from any person seeking to do business with the State. By execution of any response in this procurement, you attest, for your entire organization and its employees or agents, that you are not aware that any such gift has been offered, accepted, or promised by any employees of your organization.

SIGNATURE OF CONTRACTOR

_____
Full name of Corporation

_____
Address as Prequalified

Attest _____ By _____

Secretary/Assistant Secretary
Select appropriate title

President/Vice President/Assistant Vice President
Select appropriate title

_____ _____
Print or type Signer's name Print or type Signer's name

CORPORATE SEAL

AFFIDAVIT MUST BE NOTARIZED

Subscribed and sworn to before me this the

_____ day of _____ 20__.

NOTARY SEAL

_____
Signature of Notary Public

of _____County

State of _____

My Commission Expires:_____

EXECUTION OF BID
NON-COLLUSION AFFIDAVIT, DEBARMENT CERTIFICATION AND GIFT BAN CERTIFICATION

PARTNERSHIP

The person executing the bid, on behalf of the Bidder, being duly sworn, solemnly swears (or affirms) that neither he, nor any official, agent or employee of the bidder has entered into any agreement, participated in any collusion, or otherwise taken any action which is in restraint of free competitive bidding in connection with any bid or contract, that the bidder has not been convicted of violating *N.C.G.S. § 133-24* within the last three years, and that the Bidder intends to do the work with its own bonafide employees or subcontractors and is not bidding for the benefit of another contractor.

In addition, execution of this bid in the proper manner also constitutes the Bidder's certification of status under penalty of perjury under the laws of the United States in accordance with the Debarment Certification attached, provided that the Debarment Certification also includes any required statements concerning exceptions that are applicable.

N.C.G.S. § 133-32 and Executive Order 24 prohibit the offer to, or acceptance by, any State Employee of any gift from anyone with a contract with the State, or from any person seeking to do business with the State. By execution of any response in this procurement, you attest, for your entire organization and its employees or agents, that you are not aware that any such gift has been offered, accepted, or promised by any employees of your organization.

SIGNATURE OF CONTRACTOR

_____ By _____

Signature of Witness — Signature of Partner

_____ _____

Print or type Signer's name — Print or type Signer's name

AFFIDAVIT MUST BE NOTARIZED

Subscribed and sworn to before me this the **NOTARY SEAL**

_____ day of _____ 20__.

_____

Signature of Notary Public

of _____County

State of _____

My Commission Expires:_____

EXECUTION OF BID
NON-COLLUSION AFFIDAVIT, DEBARMENT CERTIFICATION AND GIFT BAN CERTIFICATION

LIMITED LIABILITY COMPANY

The person executing the bid, on behalf of the Bidder, being duly sworn, solemnly swears (or affirms) that neither he, nor any official, agent or employee of the bidder has entered into any agreement, participated in any collusion, or otherwise taken any action which is in restraint of free competitive bidding in connection with any bid or contract, that the bidder has not been convicted of violating *N.C.G.S. § 133-24* within the last three years, and that the Bidder intends to do the work with its own bonafide employees or subcontractors and is not bidding for the benefit of another contractor.

In addition, execution of this bid in the proper manner also constitutes the Bidder's certification of status under penalty of perjury under the laws of the United States in accordance with the Debarment Certification attached, provided that the Debarment Certification also includes any required statements concerning exceptions that are applicable.

N.C.G.S. § 133-32 and Executive Order 24 prohibit the offer to, or acceptance by, any State Employee of any gift from anyone with a contract with the State, or from any person seeking to do business with the State. By execution of any response in this procurement, you attest, for your entire organization and its employees or agents, that you are not aware that any such gift has been offered, accepted, or promised by any employees of your organization.

SIGNATURE OF CONTRACTOR

_____
Full Name of Firm

_____
Address as Prequalified

_____ _____
Signature of Witness | Signature of Member/Manager/Authorized Agent
Select appropriate title

_____ _____
Print or type Signer's name | Print or type Signer's Name

AFFIDAVIT MUST BE NOTARIZED

Subscribed and sworn to before me this the

_____ day of _____ 20__.

NOTARY SEAL

_____
Signature of Notary Public

of _____County

State of _____

My Commission Expires:_____

EXECUTION OF BID
NON-COLLUSION AFFIDAVIT, DEBARMENT CERTIFICATION AND GIFT BAN CERTIFICATION
JOINT VENTURE (2) or (3)

The person executing the bid, on behalf of the Bidder, being duly sworn, solemnly swears (or affirms) that neither he, nor any official, agent or employee of the bidder has entered into any agreement, participated in any collusion, or otherwise taken any action which is in restraint of free competitive bidding in connection with any bid or contract, that the bidder has not been convicted of violating *N.C.G.S. § 133-24* within the last three years, and that the Bidder intends to do the work with its own bonafide employees or subcontractors and is not bidding for the benefit of another contractor.

In addition, execution of this bid in the proper manner also constitutes the Bidder's certification of status under penalty of perjury under the laws of the United States in accordance with the Debarment Certification attached, provided that the Debarment Certification also includes any required statements concerning exceptions that are applicable.

N.C.G.S. § 133-32 and Executive Order 24 prohibit the offer to, or acceptance by, any State Employee of any gift from anyone with a contract with the State, or from any person seeking to do business with the State. By execution of any response in this procurement, you attest, for your entire organization and its employees or agents, that you are not aware that any such gift has been offered, accepted, or promised by any employees of your organization.

SIGNATURE OF CONTRACTOR

Instructions: **2 Joint Venturers** Fill in lines (1), (2) and (3) and execute. **3 Joint Venturers** Fill in lines (1), (2), (3) and (4) and execute. On Line (1), fill in the name of the Joint Venture Company. On Line (2), fill in the name of one of the joint venturers and execute below in the appropriate manner. On Line (3), print or type the name of the other joint venturer and execute below in the appropriate manner. On Line (4), fill in the name of the third joint venturer, if applicable and execute below in the appropriate manner.

Signature of Witness or Attest	By	Signature of Contractor
Print or type Signer's name		Print or type Signer's name
If Corporation, affix Corporate Seal	and	
Signature of Witness or Attest	By	Signature of Contractor
Print or type Signer's name		Print or type Signer's name
If Corporation, affix Corporate Seal	and	
Signature of Witness or Attest	By	Signature of Contractor
Print or type Signer's name		Print or type Signer's name

If Corporation, affix Corporate Seal

NOTARY SEAL
Affidavit must be notarized for Line (2)
Subscribed and sworn to before me this
_____day of_____ 20___
_____
Signature of Notary Public
of _____County
State of _____
My Commission Expires:_____

NOTARY SEAL
Affidavit must be notarized for Line (3)
Subscribed and sworn to before me this
_____day of _____ 20___
_____
Signature of Notary Public
of _____County
State of _____
My Commission Expires:_____

NOTARY SEAL
Affidavit must be notarized for Line (4)
Subscribed and sworn to before me this
____day of _____ 20_____
_____
Signature of Notary Public
of _____County
State of _____
My Commission Expires:_____

EXECUTION OF BID
NON-COLLUSION AFFIDAVIT, DEBARMENT CERTIFICATION AND GIFT BAN CERTIFICATION

INDIVIDUAL DOING BUSINESS UNDER A FIRM NAME

The person executing the bid, on behalf of the Bidder, being duly sworn, solemnly swears (or affirms) that neither he, nor any official, agent or employee of the bidder has entered into any agreement, participated in any collusion, or otherwise taken any action which is in restraint of free competitive bidding in connection with any bid or contract, that the bidder has not been convicted of violating *N.C.G.S. § 133-24* within the last three years, and that the Bidder intends to do the work with its own bonafide employees or subcontractors and is not bidding for the benefit of another contractor.

In addition, execution of this bid in the proper manner also constitutes the Bidder's certification of status under penalty of perjury under the laws of the United States in accordance with the Debarment Certification attached, provided that the Debarment Certification also includes any required statements concerning exceptions that are applicable.

N.C.G.S. § 133-32 and Executive Order 24 prohibit the offer to, or acceptance by, any State Employee of any gift from anyone with a contract with the State, or from any person seeking to do business with the State. By execution of any response in this procurement, you attest, for your entire organization and its employees or agents, that you are not aware that any such gift has been offered, accepted, or promised by any employees of your organization.

SIGNATURE OF CONTRACTOR

Name of Contractor _____
Individual name

Trading and doing business as _____
Full name of Firm

_____ _____
Signature of Witness Signature of Contractor, Individually

_____ _____
Print or type Signer's name Print or type Signer's name

AFFIDAVIT MUST BE NOTARIZED

Subscribed and sworn to before me this the

NOTARY SEAL

_____ day of _____ 20__.

_____
Signature of Notary Public

of _____County

State of _____

My Commission Expires:_____

EXECUTION OF BID
NON-COLLUSION AFFIDAVIT, DEBARMENT CERTIFICATION AND GIFT BAN CERTIFICATION

INDIVIDUAL DOING BUSINESS IN HIS OWN NAME

The person executing the bid, on behalf of the Bidder, being duly sworn, solemnly swears (or affirms) that neither he, nor any official, agent or employee of the bidder has entered into any agreement, participated in any collusion, or otherwise taken any action which is in restraint of free competitive bidding in connection with any bid or contract, that the bidder has not been convicted of violating *N.C.G.S. § 133-24* within the last three years, and that the Bidder intends to do the work with its own bonafide employees or subcontractors and is not bidding for the benefit of another contractor.

In addition, execution of this bid in the proper manner also constitutes the Bidder's certification of status under penalty of perjury under the laws of the United States in accordance with the Debarment Certification attached, provided that the Debarment Certification also includes any required statements concerning exceptions that are applicable.

N.C.G.S. § 133-32 and Executive Order 24 prohibit the offer to, or acceptance by, any State Employee of any gift from anyone with a contract with the State, or from any person seeking to do business with the State. By execution of any response in this procurement, you attest, for your entire organization and its employees or agents, that you are not aware that any such gift has been offered, accepted, or promised by any employees of your organization.

SIGNATURE OF CONTRACTOR

Name of Contractor _____
Print or type Individual name

_____
Address as Prequalified

_____
Signature of Contractor, Individually

_____
Print or type Signer's Name

_____
Signature of Witness

_____
Print or type Signer's name

AFFIDAVIT MUST BE NOTARIZED

Subscribed and sworn to before me this the

NOTARY SEAL

_____ day of _____ 20__.

_____
Signature of Notary Public

of _____County

State of _____

My Commission Expires:_____

DEBARMENT CERTIFICATION

Conditions for certification:

1. The prequalified bidder shall provide immediate written notice to the Department if at any time the bidder learns that his certification was erroneous when he submitted his debarment certification or explanation filed with the Department, or has become erroneous because of changed circumstances.

2. The terms *covered transaction, debarred, suspended, ineligible, lower tier covered transaction, participant, person, primary covered transaction, principal, proposal,* and *voluntarily excluded,* as used in this provision, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive Order 12549. A copy of the Federal Rules requiring this certification and detailing the definitions and coverages may be obtained from the Contract Officer of the Department.

3. The prequalified bidder agrees by submitting this form, that he will not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in NCDOT contracts, unless authorized by the Department.

4. For Federal Aid projects, the prequalified bidder further agrees that by submitting this form he will include the Federal-Aid Provision titled *Required Contract Provisions Federal-Aid Construction Contract (Form FHWA PR* 1273) provided by the Department, without subsequent modification, in all lower tier covered transactions.

5. The prequalified bidder may rely upon a certification of a participant in a lower tier covered transaction that he is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless he knows that the certification is erroneous. The bidder may decide the method and frequency by which he will determine the eligibility of his subcontractors.

6. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this provision. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

7. Except as authorized in paragraph 6 herein, the Department may terminate any contract if the bidder knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available by the Federal Government.

DEBARMENT CERTIFICATION

The prequalified bidder certifies to the best of his knowledge and belief, that he and his principals:

a. Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

b. Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records; making false statements; or receiving stolen property;

c. Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph b. of this certification; and

d. Have not within a three-year period preceding this proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

e. Will submit a revised Debarment Certification immediately if his status changes and will show in his bid proposal an explanation for the change in status.

If the prequalified bidder cannot certify that he is not debarred, he shall provide an explanation with this submittal. An explanation will not necessarily result in denial of participation in a contract.

Failure to submit a non-collusion affidavit and debarment certification will result in the prequalified bidder's bid being considered non-responsive.

☐ Check here if an explanation is attached to this certification.

LISTING ON MBE/WBE SUBCONTRACTORS

Firm Name and Address	Circle One	Item No.	Item Description	* Agreed upon Unit Price	** Dollar Volume of Item
Name Address	MBE WBE				
Name Address	MBE WBE				
Name Address	MBE WBE				
Name Address	MBE WBE				
Name Address	MBE WBE				
Name Address	MBE WBE				
Name Address	MBE WBE				

***** The Dollar Volume shown in this column shall be the Actual Price Agreed Upon by the Prime Contractor and the MBE/WBE subcontractor, and these prices will be used to determine the percentage of the MBE/WBE participation in the contract.
** Dollar Volume of MBE/WBE Subcontractor Percentage of Total Contract Bid Price:
If firm is a Material Supplier Only, show Dollar Volume as 60% of Agreed Upon Amount from Letter of Intent.
If firm is a Manufacturer, show Dollar Volume as 100% of Agreed Upon Amount from Letter of Intent.

Firm Name and Address	Circle One	Item No.	Item Description	* Agreed upon Unit Price	** Dollar Volume of Item
Name Address	MBE WBE				
Name Address	MBE WBE				
Name Address	MBE WBE				
Name Address	MBE WBE				
Name Address	MBE WBE				
Name Address	MBE WBE				

***** The Dollar Volume shown in this column shall be the Actual Price Agreed Upon by the Prime Contractor and the MBE/WBE subcontractor, and these prices will be used to determine the percentage of the MBE/WBE participation in the contract.

** Dollar Volume of MBE/WBE Subcontractor Percentage of Total Contract Bid Price:

**** Dollar Volume of MBE Subcontractor $ _____**

MBE Percentage of Total Contract Bid Price _____%

**** Dollar Volume of WBE Subcontractor $ _____**

WBE Percentage of Total Contract Bid Price _____%

If firm is a Material Supplier Only, show Dollar Volume as 60% of Agreed Upon Amount from Letter of Intent.
If firm is a Manufacturer, show Dollar Volume as 100% of Agreed Upon Amount from Letter of Intent.

ADDENDA

ADDENDUM #1

I, _____ representing _____
(SIGNATURE)

Acknowledge receipt of Addendum #1.

ADDENDUM #2

I, _____ representing _____
(SIGNATURE)

Acknowledge receipt of Addendum #2.

ADDENDUM #3

I, _____ representing _____
(SIGNATURE)

Acknowledge receipt of Addendum #3.

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH, NC

BID BOND

Contract Number: DG00231 County: Guilford County

KNOW ALL MEN BY THESE PRESENTS, That we, the PRINCIPAL CONTRACTOR (hereafter, PRINCIPAL) and SURETY above named, are held and firmly bound unto the Department of Transportation in the full and just sum of five (5) percent of the total amount bid by the Principal for the project stated above, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

NOW, THEREFORE, the condition of this obligation is: the Principal shall not withdraw its bid within sixty (60) days after the opening of the bids, or within such other time period as may be provided in the proposal, and if the Board of Transportation shall award a contract to the Principal, the Principal shall, within fourteen (14) calendar days after written notice of award is received by him, provide bonds with good and sufficient surety, as required for the faithful performance of the contract and for the protection of all persons supplying labor, material, and equipment for the prosecution of the work. In the event the Principal requests permission to withdraw his bid due to mistake in accordance with the provisions of Article 103-3 of the *Standard Specifications for Roads and Structures*, the conditions and obligations of this Bid Bond shall remain in full force and effect until the Department of Transportation makes a final determination to either allow the bid to be withdrawn or to proceed with award of the contract. In the event a determination is made to award the contract, the Principal shall have fourteen (14) calendar days to comply with the requirements set forth above. In the event the Principal withdraws its bid after bids are opened except as provided in Article 103-3, or after award of the contract has been made fails to execute such additional documents as may be required and to provide the required bonds within the time period specified above, then the amount of the bid bond shall be immediately paid to the Department of Transportation as liquidated damages.

IN TESTIMONY WHEREOF, the Principal and Surety have caused these presents to be duly signed and sealed.

This the _____ day of _____, 20 _____

_____
Surety

By _____
General Agent or Attorney-in-Fact Signature

Seal of Surety

_____
Print or type Signer's Name

BID BOND

CORPORATION

SIGNATURE OF CONTRACTOR (Principal)

Full name of Corporation

Address as prequalified

By _____

Signature of **President**, **Vice President**, **Assistant Vice President**
Select appropriate title

Print or type Signer's name

Affix Corporate Seal

Attest _____

Signature of **Secretary**, **Assistant Secretary**
Select appropriate title

Print or type Signer's name

BID BOND

LIMITED LIABILITY COMPANY

SIGNATURE OF CONTRACTOR (Principal)

Name of Contractor _____

Full name of Firm

_____

Address as prequalified

Signature of Member/ Manager/Authorized Agent _____

Individually

_____

Print or type Signer's name

BID BOND

INDIVIDUAL DOING BUSINESS UNDER A FIRM NAME

SIGNATURE OF CONTRACTOR (Principal)

Name of Contractor _____
Individual Name

Trading and doing business as _____
Full name of Firm

_____
Address as prequalified

Signature of Contractor _____
Individually

_____
Print or type Signer's name

_____
Signature of Witness

_____
Print or type Signer's name

BID BOND

INDIVIDUAL DOING BUSINESS IN HIS OWN NAME

SIGNATURE OF CONTRACTOR (Principal)

Name of Contractor _____

Print or type Individual Name

_____

Address as prequalified

Signature of Contractor _____

Individually

_____

Print or type Signer's name

_____

Signature of Witness

_____

Print or type Signer's name

BID BOND

PARTNERSHIP

SIGNATURE OF CONTRACTOR (Principal)

_____

Full name of Partnership

_____

Address as prequalified

By _____

Signature of Partner

_____

Print or type Signer's name

_____

Signature of Witness

_____

Print or type Signer's name

BID BOND
JOINT VENTURE (2 or 3)
SIGNATURE OF CONTRACTORS (Principal)

Instructions to Bidders: **2 Joint Ventures**, Fill in lines (1), (2) and (3) and execute. **3 Joint Venturers** Fill in lines (1), (2), (3), (4) and execute. Line (1), print or type the name of Joint Venture. On line (2), print or type the name of one of the joint venturers and execute below in the appropriate manner required by Article 102-8 of the *Specifications*. On Line (3), print or type the name of second joint venturer and execute below in the appropriate manner required by said article of the Specifications. On Line (4), print or type the name of the third joint venturer, if applicable and execute below in the appropriate manner required by said article of the Specifications. This form of execution must be strictly followed.

Signature of Witness or Attest	By	Signature of Contractor
Print or type Signer's name		Print or type Signer's name
	and	
Signature of Witness or Attest	By	Signature of Contractor
Print or type Signer's name		Print or type Signer's name
	and	
Signature of Witness or Attest	By	Signature of Contractor
Print or type Signer's name		Print or type Signer's name

County : Guilford

Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
			STRUCTURE ITEMS			
0001	0000100000-N	800	MOBILIZATION	Lump Sum	L.S.	
0002	0029000000-N	SP	REINFORCED BRIDGE APPROACH FILL, STATION ********** STA 15+47.50 -L-	Lump Sum	L.S.	
0003	0043000000-N	226	GRADING	Lump Sum	L.S.	
0004	0050000000-E	226	SUPPLEMENTARY CLEARING & GRUBBING	1 ACR		
0005	0134000000-E	240	DRAINAGE DITCH EXCAVATION	65 CY		
0006	0195000000-E	265	SELECT GRANULAR MATERIAL	100 CY		
0007	0318000000-E	300	FOUNDATION CONDITIONING MATERIAL, MINOR STRUCTURES	30 TON		
0008	0320000000-E	300	FOUNDATION CONDITIONING GEOTEXTILE	100 SY		
0009	0335200000-E	305	15" DRAINAGE PIPE	184 LF		
0010	0335300000-E	305	18" DRAINAGE PIPE	48 LF		
0011	0335850000-E	305	**" DRAINAGE PIPE ELBOWS 15	2 EA		
0012	0448300000-E	310	18" RC PIPE CULVERTS, CLASS IV	48 LF		
0013	0453000000-E	310	**" PIPE END SECTION 15	1 EA		
0014	1121000000-E	520	AGGREGATE BASE COURSE	605 TON		
0015	1220000000-E	545	INCIDENTAL STONE BASE	50 TON		
0016	1330000000-E	607	INCIDENTAL MILLING	1,400 SY		
0017	1489000000-E	610	ASPHALT CONC BASE COURSE, TYPE B25.0B	270 TON		
0018	1498000000-E	610	ASPHALT CONC INTERMEDIATE COURSE, TYPE I19.0B	380 TON		

County : Guilford

Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0019	1519000000-E	610	ASPHALT CONC SURFACE COURSE, TYPE S9.5B	760 TON		
0020	1575000000-E	620	ASPHALT BINDER FOR PLANT MIX	80 TON		
0021	2286000000-N	840	MASONRY DRAINAGE STRUCTURES	2 EA		
0022	2354200000-N	840	FRAME WITH GRATE, STD 840.24	2 EA		
0023	2556000000-E	846	SHOULDER BERM GUTTER	90 LF		
0024	3030000000-E	862	STEEL BM GUARDRAIL	375 LF		
0025	3150000000-N	862	ADDITIONAL GUARDRAIL POSTS	5 EA		
0026	3215000000-N	862	GUARDRAIL ANCHOR UNITS, TYPE III	4 EA		
0027	3270000000-N	SP	GUARDRAIL ANCHOR UNITS, TYPE 350	4 EA		
0028	3380000000-E	862	TEMPORARY STEEL BM GUARDRAIL	50 LF		
0029	3387000000-N	862	TEMPORARY GUARDRAIL ANCHOR UNITS, TYPE ********** III	4 EA		
0030	3389000000-N	SP	TEMPORARY GUARDRAIL ANCHOR UNITS, TYPE ********** 350	4 EA		
0031	3649000000-E	876	RIP RAP, CLASS B	65 TON		
0032	3656000000-E	876	GEOTEXTILE FOR DRAINAGE	1,025 SY		
0033	4399000000-N	1105	TEMPORARY TRAFFIC CONTROL	Lump Sum	L.S.	
0034	4686000000-E	1205	THERMOPLASTIC PAVEMENT MARKING LINES (4", 120 MILS)	2,662 LF		
0035	4810000000-E	1205	PAINT PAVEMENT MARKING LINES (4")	2,520 LF		
0036	6000000000-E	1605	TEMPORARY SILT FENCE	3,155 LF		

County : Guilford

Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0037	6006000000-E	1610	STONE FOR EROSION CONTROL, CLASS A	225 TON		
0038	6009000000-E	1610	STONE FOR EROSION CONTROL, CLASS B	160 TON		
0039	6012000000-E	1610	SEDIMENT CONTROL STONE	295 TON		
0040	6015000000-E	1615	TEMPORARY MULCHING	4 ACR		
0041	6018000000-E	1620	SEED FOR TEMPORARY SEEDING	150 LB		
0042	6021000000-E	1620	FERTILIZER FOR TEMPORARY SEEDING	0.5 TON		
0043	6024000000-E	1622	TEMPORARY SLOPE DRAINS	200 LF		
0044	6029000000-E	SP	SAFETY FENCE	100 LF		
0045	6030000000-E	1630	SILT EXCAVATION	120 CY		
0046	6036000000-E	1631	MATTING FOR EROSION CONTROL	7,800 SY		
0047	6038000000-E	SP	PERMANENT SOIL REINFORCEMENT MAT	300 SY		
0048	6042000000-E	1632	1/4" HARDWARE CLOTH	570 LF		
0049	6070000000-N	1639	SPECIAL STILLING BASINS	6 EA		
0050	6071010000-E	SP	WATTLE	30 LF		
0051	6071020000-E	SP	POLYACRYLAMIDE (PAM)	10 LB		
0052	6071030000-E	1640	COIR FIBER BAFFLE	35 LF		
0053	6084000000-E	1660	SEEDING & MULCHING	4 ACR		
0054	6087000000-E	1660	MOWING	2 ACR		
0055	6090000000-E	1661	SEED FOR REPAIR SEEDING	50 LB		
0056	6093000000-E	1661	FERTILIZER FOR REPAIR SEEDING	0.25 TON		

County : Guilford

Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0057	6096000000-E	1662	SEED FOR SUPPLEMENTAL SEEDING	100 LB		
0058	6108000000-E	1665	FERTILIZER TOPDRESSING	3 TON		
0059	6114500000-N	1667	SPECIALIZED HAND MOWING	10 MHR		
0060	6117000000-N	SP	RESPONSE FOR EROSION CONTROL	25 EA		
0061	6123000000-E	1670	REFORESTATION	0.25 ACR		
0062	8042000000-N	402	REMOVAL OF EXISTING STRUCTURES AT STATION ********** STA 15+47.50 -L-	Lump Sum	L.S.	
0063	8084000000-N	410	FOUNDATION EXCAVATION FOR END BENT ** AT STATION ********** 1, 14+90.00 -L-	Lump Sum	L.S.	
0064	8084000000-N	410	FOUNDATION EXCAVATION FOR END BENT ** AT STATION ********** 2, 16+05.00 -L-	Lump Sum	L.S.	
0065	8105520000-E	411	3'-0" DIA DRILLED PIERS IN SOIL	66 LF		
0066	8105620000-E	411	3'-0" DIA DRILLED PIERS NOT IN SOIL	45 LF		
0067	8115000000-N	411	CSL TESTING	2 EA		
0068	8121000000-N	412	UNCLASSIFIED STRUCTURE EXCAVATION AT STATION ******** 15+47.50 -L-	Lump Sum	L.S.	
0069	8147000000-E	420	REINFORCED CONCRETE DECK SLAB	6,262 SF		
0070	8161000000-E	420	GROOVING BRIDGE FLOORS	8,004 SF		
0071	8182000000-E	420	CLASS A CONCRETE (BRIDGE)	118.3 CY		
0072	8210000000-N	422	BRIDGE APPROACH SLABS, STATION ********** 15+47.50 -L-	Lump Sum	L.S.	
0073	8217000000-E	425	REINFORCING STEEL (BRIDGE)	20,931 LB		

County : Guilford

Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0074	8238000000-E	425	SPIRAL COLUMN REINFORCING STEEL (BRIDGE)	2,960 LB		
0075	8259000000-E	430	36" PRESTRESSED CONCRETE GIRDERS	780 LF		
0076	8364000000-E	450	HP12X53 STEEL PILES	245 LF		
0077	8391000000-N	450	STEEL PILE POINTS	14 EA		
0078	8503000000-E	460	CONCRETE BARRIER RAIL	226.7 LF		
0079	8608000000-E	876	RIP RAP CLASS II (2'-0" THICK)	410 TON		
0080	8622000000-E	876	GEOTEXTILE FOR DRAINAGE	465 SY		
0081	8657000000-N	430	ELASTOMERIC BEARINGS	Lump Sum	L.S.	

EXECUTION OF CONTRACT

Contract No: DG00231

County: Guilford County

ACCEPTED BY THE DEPARTMENT

_____

Proposals Engineer

_____

Date

EXECUTION OF CONTRACT AND BONDS
APPROVED AS TO FORM:

_____

Division Engineer

_____

Date